bureau. It is known as No. 72 in the series of special consular reports, and may be obtained for $1 from the Superintendent of Documents, Washington, D. C.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS—Proceedings of Annual Meeting Held at Rochester, N. Y., June 22-25, 1915. Chicago, Ill. (c/o M., St. P. & S. S. M. Ry.): P. W. Drew, Secretary Paper; 6x9 in; pp. 270.

A BIBLIOGRAPHY OF MUNICIPAL GOVERNMENT IN THE UNITED STATES—By William Bennett Munro, Professor of Municipal Government, Harvard University. Cambridge, Mass.: Harvard University Press. Cloth; 6x9 in.; pp. xiii + 472. $2.50, net.

THE BOOK OF WIRELESS: Being a Clear Description of Wireless Telegraph Sets and How to Make and Operate Them, Together with a Simple Explanation of How Wireless Works—By A. Frederick Collins, Author of "Wireless Telegraphy, Its History, Theory and Practice," "The Book of Stars," "The Book of Magic," etc. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. xv + 222; 219 illustrations. $1, net.

CANADIAN RAILWAY AND CANAL STATISTICS: Annual Report of the Department of Railways and Canals for 1913-14; Railway Statistics for 1914; Canal Statistics for the Season of Navigation, 1914—Ottawa, Ont.: Department of Railways and Canals. Paper; 7x10 in.; pp. 472; 109; 191; illustrated.

COMPASS SURVEYING AND THE SIMPLIFIED CALCULATION OF FARM AREAS—By Charles Mitchell Thomas, Civil Engineer and Surveyor. Wytheville, Va.: The Author. Cloth; 6x8 in.; pp. vi + 92; charts. $2.

ELECTRIC WIRING SPECIFICATIONS—By J. H. Montgomery, Professor of Physics and Electrical Engineering, University of Southern California. New York: D. Van Nostrand Co. Cloth; 4x7 in.; pp. 139. $1, net.

ELECTRICAL MEASUREMENTS AND METER TESTING: A Book in Plain English for the Student and Practical Man; Fundamental Theory, Practical Applications and Examples—By David Penn Moreton, Associate Professor of Electrical Engineering, Armour Institute of Technology. Chicago, Ill.: Frederick J. Drake & Co. Linen; 4x7 in.; pp. 328; 191 illustrations. $1.

HANDBOOK OF THERMODYNAMIC TABLES AND DIAGRAMS: A Selection of Tables and Diagrams from "Engineering Thermodynamics" by Charles Edward Lucke, Professor of Mechanical Engineering, Columbia University —Arranged and Amplified by John J. Flather, Professor of Mechanical Engineering, University of Minnesota. Cloth; 6x9 in.; pp. xvi + 238; 82 charts. $1.50, net.

IDIOSYNCRASIES OF UNDERGROUND WATER—By Robert E. Horton, Consulting Hydraulic Engineer, 57 No. Pine Ave., Albany, N. Y. [Reprinted from Proceedings of the Connecticut Society of Civil Engineers for 1915.] Paper; 6x9 in.; pp. 56; illustrated.

INTERNAL COMBUSTION ENGINES, Theory and Design: A Textbook on Gas and Oil Engines for Engineers and Students in Engineering—By Robert L. Streeter, Assistant Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute. New York and London: McGraw-Hill Book Co., Inc. Cloth; 7x10 in.; pp. xi + 418; 240 text illustrations and drawings. $4, net.

AN INVESTIGATION OF IOWA FIRE CLAYS—By Milton F. Beecher. Bulletin 40, Engineering Experiment Station. Ames, Iowa: Iowa State College of Agriculture and Mechanic Arts. Paper; 6x9 in.; pp. 117; illustrated.

IRRIGATION AND SETTLEMENT IN AMERICA—By A. D. Lewis, Circle Engineer, Irrigation Department, Union of South Africa; late of the Public Works Department of Punjab, India. Pretoria, South Africa: Government Printing and Stationery Office. Cloth; 8x11 in.; pp. 258; illustrated. 10/6 post free.

IRRIGATION PRACTICE AND ENGINEERING: Vol. I, Use of Irrigation Water and Irrigation Practice—By B. A. Etcheverry, Head of the Department of Irrigation, University of California. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 213; 77 illustrations. $2, net.

A MANUAL FOR HEALTH OFFICERS—By J. Scott MacNutt, Sometime Health Officer of Orange, N. J., and Member of the Board of Examiners of Health Officers and Sanitary Inspectors of New Jersey; Lecturer on Public Health Service in the Massachusetts Institute of Technology; With a Foreword by William T. Sedgwick, Professor of Biology and Public Health, Massachusetts Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 5x8 in.; pp. x + 650: $3, net.

MASTER BOILER MAKERS' ASSOCIATION—Proceedings of Annual Convention held at Chicago, May 25-28, 1915. New York (95 Liberty St.): Harry D. Vought, Secretary. Cloth; 6x9 in.; pp. 230; illustrated. $1.

THE MINERAL RESOURCES OF TEXAS—By William B. Phillips. Bulletin No. 365. Austin, Tex.: University of Texas. Paper; 6x9 in.; pp. 362; illustrated.

THE NAVAL STORES INDUSTRY—By A. W. Schorger, Chemist, and H. S. Betts, Engineer, Forest Products Laboratory. Washington, D. C.: United States Department of Agriculture. Bulletin No. 229. Paper; 6x9 in.; pp. 58; illustrated.

NEW JERSEY STATE BOARD OF PUBLIC UTILITY COMMISSIONERS (Trenton, N. J.)—Report for 1914. Cloth; 6x9 in.; pp. 307.

NEW YORK STATE COMMISSIONER OF HIGHWAYS (Albany, N. Y.)—Report for 1914. Cloth; 6x9 in.; pp. 892.

OIL ENGINES FOR PUMP IRRIGATION AND THE COST OF PUMPING—By George E. P. Smith. Bulletin 74, Agricultural Experiment Station. Tucson, Ariz.: University of Arizona. Paper; 6x9 in.; pp. 72; illustrated.

PRACTICAL SURVEYING for Surveyors' Assistants, Vocational, and High Schools—By Ernest McCullough, M. Am. Soc. C. E., author of "Engineering Work in Towns and Cities"; "The Business of Contracting"; "Engineering as a Vocation." New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. ix + 42; 229 illustrations. $2, net.

PROPERTIES OF STEAM AND AMMONIA—By G. A. Goodenough, Professor of Thermodynamics, University of Illinois. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 7x10 in.; pp. vii + 108; illustrated. $1.25, net.

THE RAILWAY LIBRARY, 1914: A Collection of Addresses and Papers on Railway Subjects, Mostly Delivered or Published During the Year Named. Also Statistics for 1914—Compiled and Edited by Slason Thompson, Director of Bureau of Railway News and Statistics. Chicago, Ill. (1529 Railway Exchange Bldg.): The Bureau. Cloth; 6x9 in.; pp. 470. $1.

THE SAMPLING AND CHEMICAL ANALYSIS OF IRON AND STEEL—By O. Bauer and E. Deiss of the Royal Testing Bureau at Gross-Lichterfelde, Germany. Authorized translation from the German by William T. Hall and Robert S. Williams, Massachusetts Institute of Technology. [International Chemical Series.] New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiv + 373; 173 illustrations. $3, net.

STANDARDS FOR RUBBER COVERED WIRES AND CABLES, Including Label Service Manual, "National Electrical Code" Specifications and Underwriters' Laboratories' Standards for Physical and Chemical Tests of Rubber Compounds Used for Electrical Insulation—Underwriters' Laboratories, Inc., 207 East Ohio St., Chicago, Ill. Paper; 6x9 in.; pp. 126; illustrated.

STRUCTURAL STEEL: Handbook No. 16—Compiled and Published by R. A. Skelton & Co., Moorgate Station Chambers, London, E. C., England. Cloth; 7x9 in.; pp. 319; illustrated.

SURVEYING AND FIELD WORK: A Practical Textbook on Surveying, Leveling and Setting-Out, Intended for the Use of Students in Technical Schools and Colleges and as a Work of Reference for Surveyors, Engineers and Architects—By James Williamson, Assoc. M. Inst. C. E. [The Glasgow Textbooks.] New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xxii + 363; 271 illustrations. $3, net.

SURVEYING MANUAL: A Manual of Field and Office Methods for the Use of Students in Surveying—By William D. Pence, M. Am. Soc. C. E., Professor of Railway Engineering, University of Wisconsin, and Milo S. Ketchum, M. Am. Soc. C. E., Dean, College of Engineering and Professor of Civil Engineering, University of Colorado. Fourth Edition. New York and London: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. xiv + 388; illustrated. $2, net.

TESTS OF SUBMERGED ORIFICE HEADGATES FOR THE MEASUREMENT OF IRRIGATION WATER—By F. L. Bixby, Irrigation Engineer. Bulletin 97, Agricultural Experiment Station. State College, N. M.: New Mexico College of Agriculture and Mechanic Arts. Paper; 6x9 in.; pp. 55; illustrated.

A TEXTBOOK OF ENGINEERING THERMODYNAMICS—By Charles Edward Lucke, Professor of Mechanical Engineering, Columbia University, and John J. Flather, Professor of Mechanical Engineering, University of Minnesota: An Abridgment of "Engineering Thermodynamics," by Charles Edward Lucke. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xxiv + 688; 189 illustrations. $5, net.

VALVES AND VALVE GEARS: Vol. II, Gasoline, Gas and Oil Engines—By Franklin DeRonde Furman, M. Am. Soc. M. E., Professor of Mechanism and Machine Design, Stevens Institute of Technology. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 190; 216 illustrations. $2, net.

WATER-SUPPLY PAPERS, U. S. GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.

No. 356: Surface Water Supply of the United States, 1913; Part VI, Missouri River Basin. Pp. 291.

No. 375-B: Ground Water in Paradise Valley, Arizona —By O. E. Meinzer and A. J. Ellis. Pp. 26.

No. 375-C: The Relation of Stream Gaging to the Science of Hydraulics—By C. H. Pierce and R. W. Davenport. Pp. 10.

No. 375-D: Ground Water in Big Smoky Valley, Nevada —By O. E. Meinzer. Pp. 31.

No. 375-E: A Method of Correcting River Discharge for a Changing Stage—By Benjamin E. Jones. Pp. 10.

Field and Office

Baby Mixer Proves Economical

Unusually efficient work was observed recently in concreting with a baby batch mixer. Rapid mixing and placing of concrete, great adaptability to conditions of ground, etc., and, to all appearances, very low cost were features of the performance. The case was the concreting of column footings for the Delco Building, a large reinforced-concrete structure now under erection at Dayton, Ohio.

The 93 footings of the building, 2 ft. to 14 ft. below ground floor and from 1 yd. to 7 yd. in contents of concrete, were ready for concreting long before the mixing plant and towers were assembled and erected. As the footing pits tended to cave, it was desired to concrete them as soon as excavated to save extra work in holding the walls or clearing the pits.

Work was begun by hand mixing, but this proved too expensive on account of rehandling sand and stone, as well as too slow—the excavation got too far ahead of the concrete.

Half-Bag Batch Mixer for Direct Depositing

A self-propelling half-bag mixer (Foote) was then brought on the job. It proved successful from the start.

The mixer was run under its own power to a point near enough to the footing so that the concrete could be chuted from the mixer to place. In many instances the gravel aggregate was taken direct from the excavation in which case only the cement had to be wheeled.

The full day's capacity of the mixer (said to be 80 cu.yd. in 10 hr.) was never used, but some very good short-time performances were made. The best was 7 yd. in 28 min., with a force consisting of one foreman, one operator, two shovelers, one material wheeler, one batch tender and one puddler. In this particular case the material was specially convenient and the mixer was placed more advantageously than usual. In numerous other cases, however, 45 yd. in 8 hr. was turned out, with two wheelers added to the gang.

Wheeling Concrete for Wall Work

For forming the walls (2 ft. to 10 ft. high) of the ground-floor sill and of the interior tunnel, a directly opposite method of using the portable mixer was employed—keeping the mixer stationary and wheeling the concrete from it to the wall. This was on account of the small yardage of concrete per foot of wall. Actually, it was found that wheeling concrete as far as 150 ft. was cheaper than moving the mixer, rehandling material and rebuilding runways.

The labor cost per yard of concrete was higher under this method than under that used for the footings because three more men were required in wheeling.

Factors of the Machine's Success

The fact that the mixer was self-propelled turned out to be very valuable. Often the machine crawled over piles of excavated dirt like a snail, but it always got there and it was mired only once.

The simplicity of the mechanism was another important element. A second-class engineer was hired and he operated it successfully. In turning out about 1000 yd. of concrete the mixer held work up only twice, and only one of these cases is chargeable to the machine.

More Use of Motor Trucks for Hauling Structural Steel

By D. P. N. Little*

I was very much interested in the article in *Engineering News* of July 22, 1915, by William Collins, Jr., describing the hauling of heavy girders for the Jerome Ave. elevated-railway structure in New York City. The article was of particular interest, for we have these hauling problems confronting us on the Pacific Coast, as well as our brothers in the East; and just at this time the Union Iron Works, of Los Angeles, had to consider the problem of

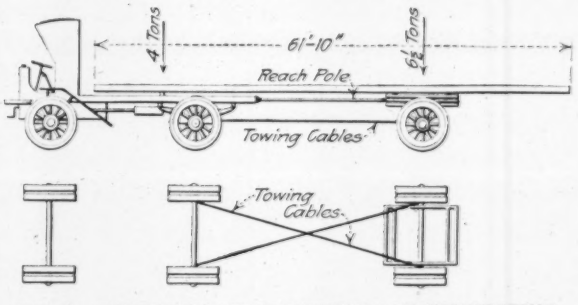


FIG. 1. SKETCH PLAN OF METHOD OF CONNECTING TRUCK AND TRAILER FOR HAULING STRUCTURAL STEEL

transporting two girders, 72 in. deep by 61 ft. 10 in. long, weighing about 11 tons each, which were designed for a bridge on Cypress Ave., between Los Angeles and Orange Counties, 24 mi. distant from the shops.

As the location was not convenient for shipping by rail, it was decided to use a 3½-ton motor truck with a two-wheeled rubber-tired trailer. The roads for most of the way are thoroughly improved, although there are quite a number of very short turns.

The accompanying sketch, Fig. 1, shows the method of loading, about 6½ tons being put on the trailer and about 4 tons on the truck.

The trailer frame has swivels at two points, and the tow-line connection of crossed wire cables from axle to axle compels the trailer to take the same circle as the rear wheels of the truck. The second swivel frame carries the reach pole, which is connected to the rear end of the truck body by a toggle joint, but it does not carry any strain. The upper swivel frame acts as a bolster and is provided with rollers. The girder was securely chained to the swivel frame of the trailer as well as to a swivel bolster on the body of the truck. Both girders were safely

*President of the Union Iron Works, Los Angeles, Calif.

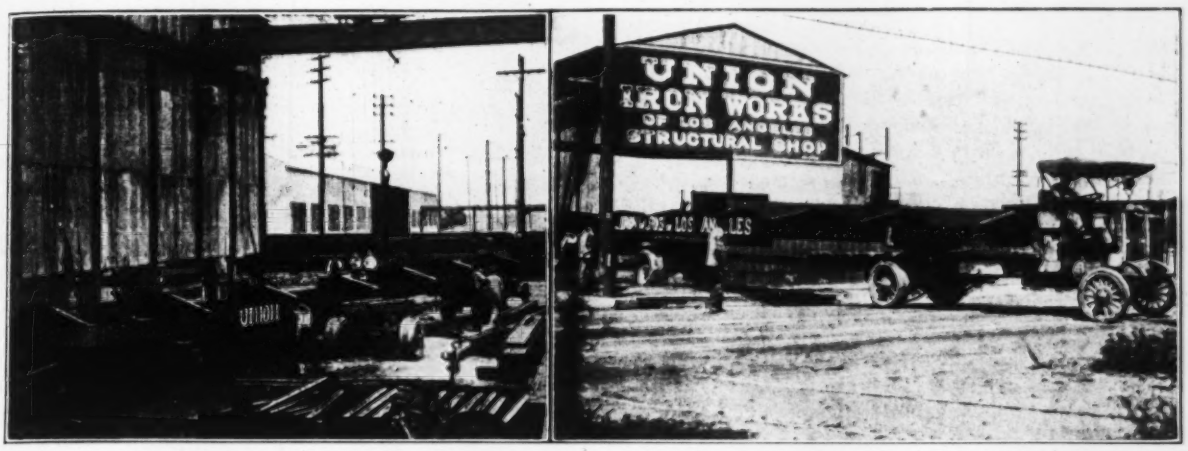


FIG. 2. LOADING AND HAULING 11-TON STEEL GIRDERS BY MOTOR TRUCK AND TRAILER

transported to their destination without incident, the time consumed from start to finish being 10 hr. for each girder. This would have been cut to 8 hr., but the weather was unusually warm and the oil-macadam roads were rather soft.

We have estimated (taking the period of the year as a basis) that the operation of our truck, including depreciation, labor, upkeep and fuel expenses, averages about $1 per hr. of operating time, and if this assumption is correct we transported these girders 24 mi. for a little less than $1 per ton. However, taking Mr. Collins' estimate of $20 per day it would make our hauling cost about $1.90 per ton, or 7.91c. per ton-mile as against Mr. Collins' 16½c.

With this same truck we have hauled steel beams 57 ft. long 66 mi. to Riverside without the use of a trailer. We find this cheaper than loading on two flat-cars.

Lifting Bridge Trusses to Adjust Rollers

By H. T. Welty*

The Ottawa & New York R.R. and the Ottawa Division of the New York Central R.R. are carried over the south channel of the St. Lawrence River near Cornwall, Ont., by a bridge consisting of three 368-ft. single-track truss spans. A recent inspection disclosed the fact that the expansion rollers (of which there are six, 12 in. high, at each expansion point) were inclined considerably more than they should be at the temperature obtaining when the inspection was made, and at two points the inclination had progressed so far that a further movement of ½ in. only was possible. It therefore became necessary to jack up the trusses and adjust the rollers.

The elevation of the bridge above the river, about 40 ft., and the swift current which prevails at this point made the use of any falsework difficult and expensive; the dimensions of the piers, which extend beyond the truss bearings only 4 ft. transverse to the axis of the bridge, and 1 ft. in the other direction, necessitated a compact device for jacking.

The device adopted consisted of a pair of U-shaped lifting rods engaging threaded cast-steel collars which replaced the nuts on the end pins. The rods were threaded at the tops for nuts which rested on loading beams, these beams being in turn supported on lifting beams against the lower flanges of which, through timber blocks, the jacks operated.

The collars were threaded from field measurements of the threads on the pins, and each was provided with a ¼-in. rim at the outer end to hold the lifting rods in position. The latter were made of 1¾-in. square rods to give a good bearing on the collars, and the inside rod was made in two parts with a turnbuckle connection to permit inserting it around the end floorbeam without disturbing the latter. The loading beams were made of two 12-in. channels bolted together through a 4-in. wood-block separator, the bearing of the lifting-rod nuts being taken

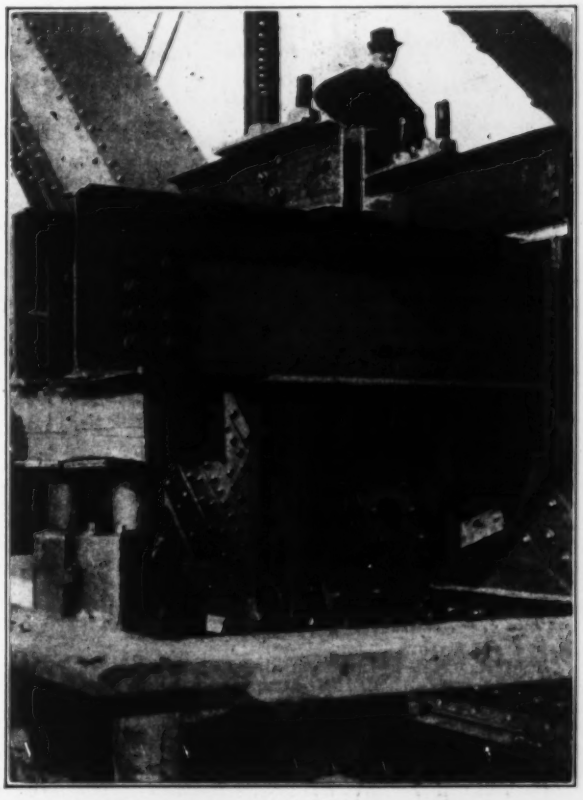


FIG. 1. VIEW OF LIFTING-DEVICE IN POSITION

*Engineer of Structures, New York Central R.R. east of Buffalo, Grand Central Terminal, New York City.

by a ¾-in. plate resting on their top flanges. These beams rested on the top flanges of the lifting beam composed of two 24-in. 80-lb. I-beams 9 ft. 3 in. long which spanned the truss shoe, one on each side of the end floorbeam. At the outer end these beams were connected over the jacking point by a 20-in. I-beam diaphragm, but at the inner end, where the floorbeam interfered, dependence was placed on bolts extending through the webs and clamping the parts together through wooden blocks.

Due to interference from the end-post, the lifting beam could not be placed nearer the top of the pier than about 5 ft., which necessitated the use of blocking. The blocking, because of the restricted area of the pier, could not be arranged to give a very ample bearing area, a high bearing pressure on the blocks resulting (see Fig. 1).

The weight to be lifted was calculated as 280,000 lb., and in order that ample jacking capacity would be available four 60-ton jacks were used.

A force of six men was employed in the work. After the preliminary details—such as drilling holes in the old material and making cuts to permit the placing of the lifting rods and beams—had been completed at all points, the lifting parts and blocking were placed at one bearing, the truss raised about one inch and the rollers adjusted, after which the lifting parts and jacks were removed to the next bearing and the same procedure repeated, and so on until all six expansion bearings were adjusted. Two bearings were adjusted each day. In some cases the roller nest was not exactly square on the bedplate and in addition to adjusting the inclination of the rollers it was necessary to adjust the position of the nest. This was done by means of a small track jack.

During the adjustment of the rollers no traffic was permitted on the bridge, and the work proceeded to completion without interruption or difficulty.

The device was designed in the office of Engineer of Structures, of the Construction Department of the N. Y. C. R.R., and the work was carried out by the Maintenance of Way Department forces under the supervision of the Assistant Engineer, Adirondack Division.

Tar Paint on Penstocks and Draft Tubes has been used successfully at the water-power plant on the Minidoka, Idaho, reclamation project, according to a report in the "Reclamation Record for September." The use of this material appears to have been due to the article on the Fernando siphon of the Los Angeles water supply, published in "Engineering News," May 21, 1914. Barry Dibble, engineer in charge of the Minidoka power plant, found that the steel draft tubes and penstocks under water were not protected from corrosion by the red-lead paints that had been applied. During the fall of 1914 the parts exposed to water on all the draft tubes were scraped clean and repainted with water-gas and coal-gas tar, the former being used for the first coat and the latter for the second and third coats. The steel was first cleaned with steel scrapers and brushes. The cost of the water-gas tar was about 15c. per gallon delivered. One gallon covered about 30 sq.yd. In cool weather, one quart of gasoline was mixed with three to five gallons of tar. The tar was applied with a brush in the same manner as ordinary oil paints. At a cost of labor for painting only of $110, and for material of $10.39, 750 sq.yd. were cleaned and painted.

Load Tests of Concrete Pipe

By E. R. Conant*

In preparation for the construction of 12 mi. of sanitary and storm-water sewers in Savannah, I made a series of load tests on the circular concrete pipe of the Meriwether type, made by the Lock Joint Pipe Co., which type is being used in about 40% of the work. These tests were made under the following specifications:

When supported upon a saddle which extends the full length of the pipe, exclusive of the bell, and whose outer surface fits accurately the outer curve surface of the pipe, and whose width is equal to an arc of 15 deg., in such a manner that an even bearing is provided throughout the whole length, and pressure is applied at the crown uniformly through a knife-edge 1 in. in width, the various sizes of pipe with diameters greater than 42 in. shall withstand the following pressures:

Diameter, In.	Pressure, Lb. per Lin.Ft.	Diameter, In.	Pressure, Lb. per Lin.Ft.
24	2,150	54	5,000
30	2,700	60	5,500
36	3,300	66	6,000
42	3,800	72	6,500
48	4,400		

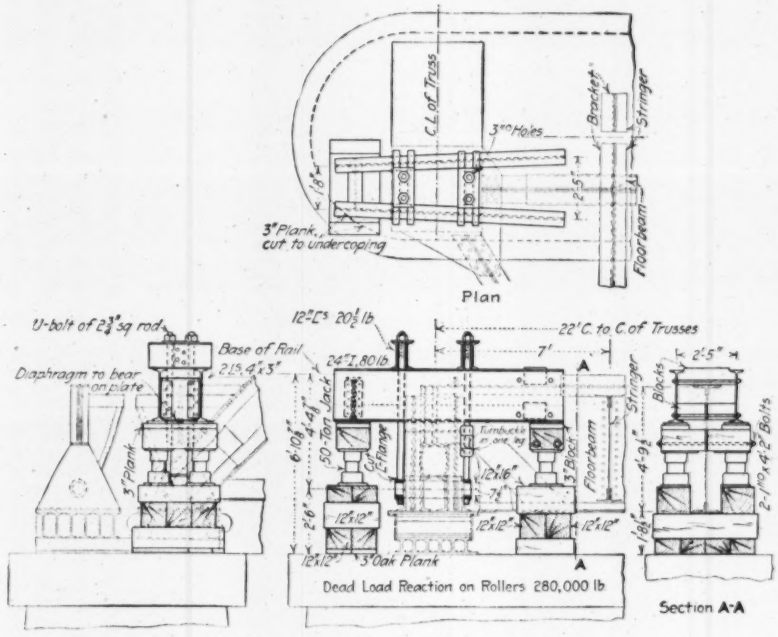


FIG. 2. ARRANGEMENT FOR LIFTING TRUSS TO ADJUST ROLLERS, CORNWALL BRIDGE

Bending tests were made on one section each of the 48-in. and 66-in. diameter pipe and on two jointed sections of 36-in. pipe. All concrete was a 1:2:4 mix using river sand and a fine crushed granite for aggregate. The reinforcement was of the standard size and disposition for this type of pipe.

The test on the 48-in. pipe is shown in Fig. 1. In this a load was placed on a 42-in. wide platform carried on a 1-in. knife-edge which rested on the top element of the pipe, the pipe itself being bedded on saddles made by laying two 1x4-in. boards on the ground. The direct load was applied by loading the platform with cement in sacks over a space 4 ft. each side of the knife-edge.

The 48-in. pipe, 48 in. long and 16 days old, showed a hair crack at the invert and crown at 4½ tons load; the deflection was inappreciable. The load was left in place

*Chief Engineer, Savannah, Ga.

FIG. 1. LOAD TEST ON 48-IN. REINFORCED CONCRETE PIPE

unchanged for 24 hr., but no change in the pipe took place. Loading was resumed until 7.35 tons, or 2.08 tons per lin.ft., had been placed. At this load the deflection was 3/8 in. and the cracks in the invert and crown opened up slightly, but no crack extended outside of the inner line of reinforcement. In this pipe American Steel & Wire Co.'s triangular mesh No. 34 was used for reinforcing, two hoops being used—the first one 3/4-in. from the outside face and the second 1 3/4 in. from the inside face of the pipe.

Similiar load test was made on a 66-in. pipe after the pipe had aged 14 days. The loading of 11½ tons was applied on a 1-in. knife-edge, producing a deflection of only 1/16 in. at the crown. A few hair-cracks occurred on the inside of the pipe at the top and bottom.

Another test was made to determine the strength of the joints (Fig. 2). Two 36-in. diameter pipes were jointed with grout in the customary manner, and the pipe was then supported at its ends and load was placed upon a 16-in. saddle centered over the joint. In this test 8½ tons was placed on the loading platform, with the result that no deflection could be noticed and no cracks occurred. The joints thus resisted a bending load greater than the required strength of the pipe.

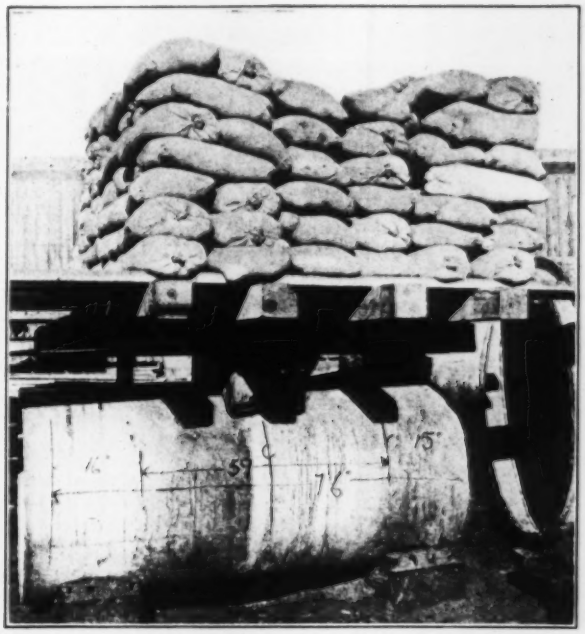


FIG. 2. TESTING THE JOINT IN LOCK-JOINT PIPE

Subdrainage of Brick-Paved Streets, Lakewood, Ohio

By E. A. Fisher*

I agree with the suggestion of the National Paving Brick Manufacturers' Association that too little attention has been paid to the question of drainage and the action of frost in water-impregnated soils. All the real reasons for the cracking of brick pavements are not fully understood, nor is it to be doubted that the expansive action of freezing water in the subsoil is responsible for some of the trouble. It would therefore seem reasonable to provide, as far as possible, against this cause.

In brick pavements recently constructed in Lakewood, Ohio, I have endeavored to provide subdrainage by placing a 3-in. tile drain behind the curb, laid in cinders as shown in Fig. 1. We used this method of construction last season in all streets with the exception of one. Of those streets in which a tile drain was placed, none has shown any signs of cracking. The one in which no tile was laid has already cracked. Subsoil conditions in the several streets are almost identical.

A condition which exists for about 2000 ft. on one side-hill street which we paved this season is shown in Fig. 2.

FIG. 1. HALF CROSS-SECTION OF BRICK-PAVED STREET WITH TILE DRAINS BEHIND CURBS

During a hard rainstorm and at intervals afterward, I visited this street to see what effect the tile drain was having. I found the 3-in. tile on the high side of the street, which discharged into the nearest catchbasin, running nearly full. The tile on the low side of the street was running nearly a quarter full.

*City Engineer of Lakewood, Ohio.

In this particular case one can very easily imagine what might happen with the ground saturated by fall rains, followed by a sharp freeze, if there were no tile drain to intercept the water from the slope.

Admitting the theory of capillarity in soils, there may be some question as to where to place the drain. I have worked on the presumption that the presence of 13 in. of

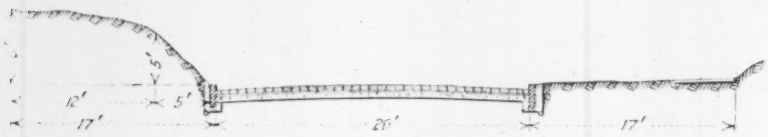
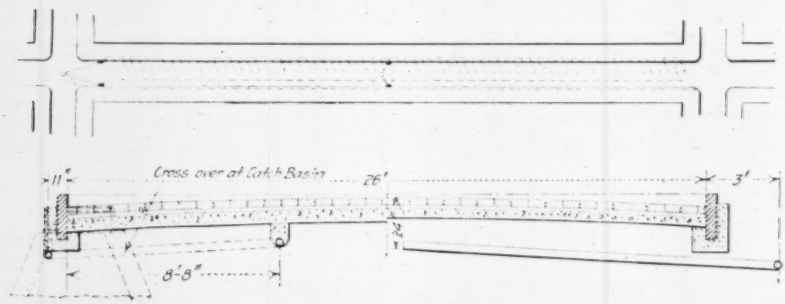


FIG. 2. CROSS-SECTION OF SIDEHILL STREET IN LAKEWOOD, OHIO

porous cinder between the tile and the nearest point of the subgrade would break down any capillarity that might exist.

The N. P. B. M. A. specifications suggest that the drain be placed 3 ft. back of the curb and that lateral drains be run from this tile drain to the center of the street. In Fig. 3 is shown a 600-ft. block with one side of the street drained with lateral tile drains 8 ft. 8 in. center to center and the other side drained longitudinally of the



FIGS. 3 AND 4. PLAN AND CROSS-SECTION OF STREET WITH TWO PROPOSED SYSTEMS OF SUBDRAINAGE

street by two tiles with the same spacing apart. In each case the drain is led to the nearest catchbasin. The saving in lineal feet of tile in the longitudinal drainage over the lateral system is about 30% for the same spacing. Fig. 4 is a cross-section of the street in Fig. 3.

I am firmly of the opinion that there is virtue in the use of a tile drain under the curb, and there may be additional virtue in the lateral drainage suggested. I shall try to find out at the first opportunity.

Explosives for Driving Concrete Piles*

In driving reinforced-concrete piles for the Cabugao Bridge, Ilicos Sur, Philippine Islands, compacted gravel sand, clay and bowlders up to 10 in. diameter were encountered, and it was decided to loosen up the material ahead of the piles by the use of explosives. It was desired to obtain a penetration to El. —6.8 m., the ground level being at approximately El. +0.2 m.

The plan was to explode the charges at El. —6.0 m., leaving 80 cm. of penetration to be obtained by driving the tapered points of the piles into the undisturbed material. Judson powder R.R.P. was used because it was decided this would exert its action through a greater range horizontally and with probably more force upward than other available explosives.

The piledriver was moved into place for driving the pile and a 6-m. length of 3-in. galvanized-iron pipe was hoisted in the leads. A pipe coupling was screwed on to the hammering end of the pipe to protect the threads in driving, and on the driving end was attached a steel cap made of old plate ½ in. thick, 7 in. square, notched on the four sides about 2 in. The corners of the plate were bent up at right angles forming a circle practically the diameter of the outside of the pipe. Into a hole punched in the center of the plate a piece of ¾-in. steel 2 in. long was driven while hot and made snug. The cap was fitted over the end of the pipe at just ground level, and the protruding point served as a guide to keep the cap and pipe going straight. The cap, while it did not keep water out of the pipe, prevented the earth from entering and filling it. While the driver was being moved into place and the pipe was being prepared for driving, the charge of explosives was simultaneously prepared. With light blows of the hammer, the pipe was driven into the ground 6 m.

The charge, really a long cartridge, was lowered into the pipe. The cartridge was a tin tube of 2½ in. diameter and 1 m. long containing Judson powder R.R.P., tamped to a depth of 75 cm. Two sticks of dynamite, with a 6-m. fuse and cap in each, were placed on top of the powder. Another stick of dynamite was broken into four pieces and tamped in around the exploder sticks along with more Judson powder R.R.P. up to within about 4 cm. of the top of the tube. On top of this was rammed some of the thin paper in which fuses are packed, and the tube was sealed with asphalt or white lead, crimping the end of the tube slightly.

When the bottom of the tube was down to the bottom of the pipe and resting on the cap, a 6-m. length of 1-in. pipe was run down on to the top of the cartridge and held there by two laborers on the piledriver. The cable was then hitched to a rope fastened around the top of the 3-in. pipe and with the engine the pipe was gradually withdrawn, leaving the cap and tube down in the ground. The 1-in. pipe was withdrawn after the 3-in. pipe had been lifted about 2 m.

As soon as the two pipes were out of the ground, the fuses were lighted and the charge exploded. The piledriver was then moved into place for the next pile but one and the operation repeated, and then to the second pile beyond that. This gave three explosions for the bent of five piles, which were spaced about 1 m. apart. The concrete piles were then driven with very satisfactory results as to grade, the bearing being much more than required. These facts should be noted:

1. There must be a steel cap on the penetrating end of the pipe as a wooden plug splinters and forces itself up into the pipe.

2. There must be a coupling on the driving end of the pipe as the metal at the base of the threads is too thin to permit of

*Abstract from an article by Frank T. James, in the "Quarterly Bulletin," Bureau of Public Works, Philippine Islands.

hammering without crimping the edges. The coupling also serves as a collar with which to grip the pipe with a rope when withdrawing it from the ground.

3. A block, preferably of hardwood, should be used on top of the coupling as a further protection for the end of the pipe.

4. The 3-in. pipe should not be driven until the cartridge is all ready, because once in awhile the cap slides off the end of the pipe when down at a considerable depth, and the charge must be put in immediately before the earth works itself into the pipe.

5. Dynamite is absolutely necessary to explode Judson powder R. R. P. The manufacturer's handbook states the size and number of sticks to be used for different sized charges. The charge used was about 6 lb. and required two ⅞-in. sticks.

6. In every charge of dynamite there should be two fuses and two caps as a minimum. One fuse and one cap are not enough as oftentimes a fuse that burns well for half its length or more dies before reaching the cap, if the latter has been crimped too much or improperly. Using two fuses and two caps lessens the chances of failure to explode. One of the fuses should be a foot or more longer than the other, and the longer one be lighted first, to insure reasonable safety to the man doing the igniting. This must be done quickly; hence a torch or other large flame is best.

Jacking Tests on Piles

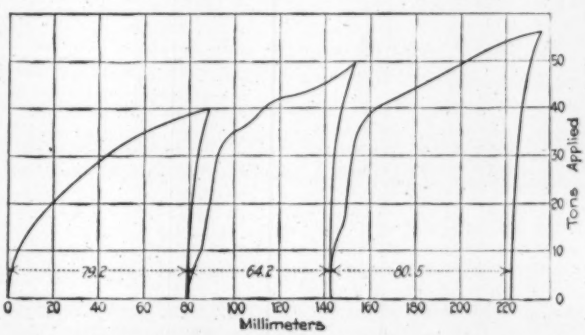
Interesting pile tests were made last spring at the Potter Building, New York City, by Maurice Deutsch, consulting engineer. The piers along the Beekman St. front of the building, on the line of the new subway, were underpinned to a depth of from 56 to 59 ft. below curb, by carrying a series of open pits under the main piers down to water level (about 44 ft. below curb) witn five tubular steel-and-concrete piles, of 14 in. diameter, jacked down below the pit bottom to about 15 ft. below water level. Each of these piles was tested to a load of 56 tons by means of a hydraulic jack. Readings were taken on a dial deflectometer. The results of three tests on one of these piles, penetrating 15 ft. in medium fine sand, are shown by the accompanying curves.

SETTLEMENT AND RECOVERY OF PILES UNDER LOAD

First Test		Second Test		Third Test	
Tons	Movement mm.	Tons	Movement mm.	Tons	Movement mm.
10	4	10	5	10	1
35	60	20	10	16	5.5
40	89.3	30	13	31	9.5
E		35	20	40	20
Recovery	10.1	38	30	45	40
Net movement	79.2	42	40	50	60
		43	50	54	80
		45	60	56	93.9
		48	70		
		50	75.3	Recovery	13.4
		Recovery	11.1	Net movement	80.5
		Net movement	64.2		

Total net movement 223.9 mm.

It is to be noted that the greatest movement was on the last test, the pile settling at a steady and fairly uniform rate as the load was increased. The recovery on the three tests seems to have been progressively greater as the tests continued and the soil became more compressed. On the third test the application of 10 tons seems to have caused practically no movement, 16 tons being required to obtain approximately the same small movement that resulted from 10 tons in the other two tests.



CURVES SHOWING MOVEMENT OF A PILE UNDER THREE SEPARATE LOADINGS

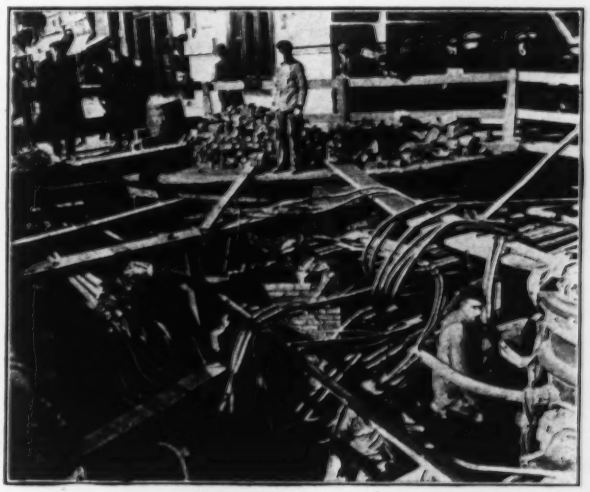
On the second application of load it took 20 tons to settle the pile the distance it had recovered on the first application, and on the third test 32 tons was applied before the pile settled the distance it had recovered after the removal of the load in the second test. In the third test, after the application of 40 tons, the settlement was more uniform with equal increements of load, than in the previous tests. Commenting upon this particular feature, Mr. Deutsch says:

> This [uniform settlement] would seem to indicate that the soil had reached its maximum resistance to compression, and that the frictional resistance between the pile and the soil having been overcome the settlement of the pile continued uniformly and was subject only to the load increase. The behavior of the soil at this point corresponds to the action of a vibratory force or hammer action applied to a pile or pier penetrating a dense material. The pile that is subjected to a vibratory force will continue to settle so long as this force is applied, and the amount of settlement will increase with the frequency of vibration, assuming the load to be constant, or assuming the frequency to be constant with the increase of the loading.

NOTES

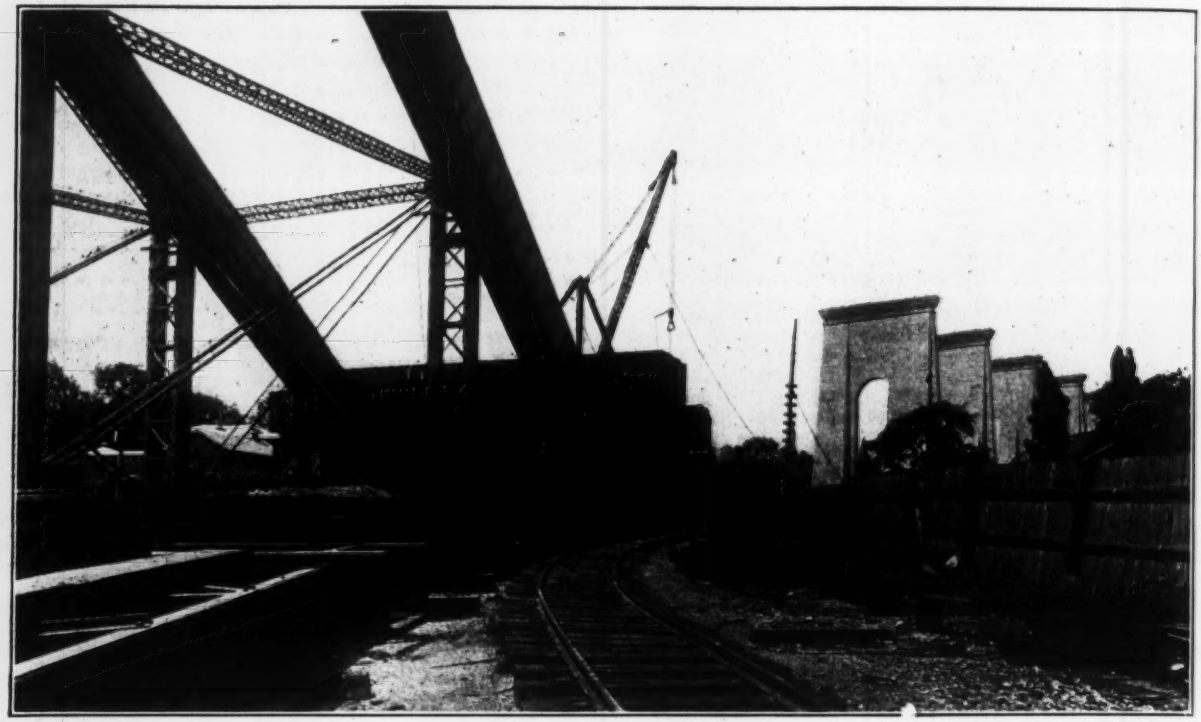
Puddled Concrete for Water-tightness was used for the basement wall of the Circle Building, recently erected in New York City. Several kinds of concrete waterproofing were tested by the contractor—the Columbus Circle Construction Corporation—but puddled gravel concrete of 1:2:5 mix was finally adopted, having stood up very satisfactorily under test. The test in question consisted of placing a 2-ft. 6-in. cube of concrete, having a hollow or core which gave 12-in. walls all around, in a trench containing water. After remaining in the water for two weeks no water was found in the core hole in the block. The concrete was puddled with scrapers such as are used to remove ice from sidewalks.

Broadway With the Cover Off is shown in the accompanying illustration. This picture shows the southwest corner of Murray St. and Broadway during the reconstruction of the various subsurface conduits, which carry the means of life



CORNER OF BROADWAY AND MURRAY ST., NEW YORK, SHOWING SUBSURFACE CONDUITS

to the city's many industries. Inquiry is sometimes made why New York City granite-block pavements are constructed with asphalt- or tar-filled joints. The accompanying picture shows the reason why. Grouted joints make a pavement too difficult to open for access to these many conduits.



WARD'S ISLAND BACKSTAY ANCHORAGE OF THE HELL GATE STEEL-ARCH BRIDGE OF THE NEW YORK CONNECTING R.R.

The Ward's Island Backstay Anchorage of the Hell Gate steel-arch bridge of the New York Connecting R.R. is shown in the accompanying view. This backstay is about 2 ft. farther from the west abutment than the east backstay is from the east abutment, but because of a slight bend in the top tie, it requires a heavier anchorage. The picture shown is from a photograph taken July 23, when the anchorage consisted of 3670 tons of steel girders, which will later be incorporated in the east viaduct approach. Before the arch is extended to the center of the span 1500 tons more will be required in this anchorage.

Another Form of Contracted Multiplication—I desire to call attention to a contracted method of multiplication I have used for some time and which I find quite valuable. In order to avoid carrying figures in the multiplication beyond the required precision, I write the multiplier under the multiplicand in the inverted order and proceed to multiply in the usual manner by using only the figures above and to the left of each figure of the multiplier. The position of the unit in the multiplier determines the number of decimal points that will be preserved in the product. In order to gain a precision to any number of decimals, the unit figure of the multiplier should be placed one point to the right of that decimal, thus preserving one figure more than necessary, which figure is used to determine the nearest number required. To illustrate, take 623.85 to be multiplied by 0.71721. In this case two decimal points are to be preserved, so that zero in the multiplier is placed under the third decimal point of the multiplicand, and the sine is written in the reversed order, thus:

$$\begin{array}{r} 623.850 \\ 12717.0 \\ \hline 436.695 \\ 6.238 \\ 4.368 \\ 124 \\ 6 \\ \hline 447.431 \\ \hline \end{array}$$

Correct value = 447.43

This accomplishes the same purpose as that sought by E. E. Thum in "Engineering News," July 15, 1915, p. 124, but in a more positive manner. I claim no originality in this matter. The person who explained this to me remarked that this was the only really valuable thing he learned while attending a university.—C. E. Day, Southern Pacific Co., San Francisco, Calif.

Producer-Gas Engine Starts on Gasoline—A producer-gas engine in the pumping station of the water-works of Riverhead, L. I., is arranged to start on gasoline when fire service puts a suddenly increased demand on the station. The engine operates successfully with both fuels, special arrangement being made to suit the gasoline charge to the compression as proportioned for producer gas. The station contains two engines rated at 50 hp. on producer gas or 70 hp. on gasoline. There is a producer for each engine. One of the units is in service for regular operations, but on fire calls it is necessary to start the second. As the producer cannot respond very promptly, the arrangement was made to start this engine on gasoline. A pump-feed carburetor was fitted with a throttle valve in the supply line to the cylinder, so that the charge can be throttled down and a mixture supplied that is not only weak in quality but low in quantity in order to avoid excessive compression and the consequent danger of preignition, etc. By throwing a valve the engine feed is changed from producer to carburetor or the reverse. The engines are Nash engines of the National Meter Co., which also put in the carburetor.

Recording Stream-Flow Gages are discussed by C. H. Pierce in "Water Supply Paper 375-F," issued by the United States Geological Survey. The author favors the use of automatic gages and cites many instances where the records they furnish are far more valuable than would be the record of a gage read by observers at occasional intervals. He further advises a preliminary study of the stream and in many cases the obtaining of preliminary records by portable recording gages before establishing a permanent gaging station.

The Cost of Aërial Tramways is given by a writer in "The Engineer" (London) for July 23, the figures being compiled from actual experience and representing plants which involve no special complications. For lines one mile long, the cost ranges from $11,500 per mile for a capacity of 10 tons per hour to $14,350 for 40 tons and $17,500 for 80 tons per hour. For lines five miles in length, of similar capacities, the cost per mile is $37,000, $52,500 and $65,500 respectively. The estimates are for the total cost of the line erected, and are based on the use of spiral-wound ropes for lines up to 20 tons capacity and locked-coil ropes for from 40 to 80 tons capacity. The operating expense per day is estimated as follows: One-mile tramway, $6 for 100 tons per day, $9 for 400 tons, and $14.50 for 1000 tons. Five-mile line, $12.75, $21 and $39.50 respectively. The operating expenses include depreciation, but not the cost of driving. This latter varies so widely with difference in elevation between terminals, etc., that it cannot be standardized and must be estimated for each plant.

Editorials

Missouri River Navigation

In *Engineering News* of Aug. 26 was noted the official recommendation of Colonel Deakyne, in charge of the United States Engineer Office at Kansas City, that the Government should expend no more money upon the improvement for navigation of the Missouri River below Kansas City. As was to be expected, this report by Colonel Deakyne has aroused great local hostility. A meeting was recently held at Kansas City, attended by 260 delegates from the states in the Missouri and Mississippi valleys, and a committee was appointed to draft a protest to the Board of Engineers for Rivers and Harbors. It was declared that the fight against the abandonment of the Missouri River would be carried into Congress, and the following resolution was adopted:

> Whereas, it is recognized that expenditure by the Federal Government on the Missouri River will greatly deepen the channel thereof and develop it into a great highway of commerce, we do here further call attention to the fact that when the river has been controlled and made navigable it will be kept within bounds and it will incidentally preserve and protect 500,000 acres of land worth $50,000,000 along its banks, now liable to overflow. The value of the land thus restored to the use of the people will be greater than the amount expended by the Government in making the river thoroughly navigable.

One wonders how many of the delegates who took part in this protest seriously believe that steamboat traffic on the Missouri River will ever become important in amount, no matter how much money the Government may spend on the improvement of the stream.

The language of the resolution quoted unconsciously reveals that the real reason why the residents of the Mississippi valley are vociferous in demanding Federal appropriations for navigation is because they wish the Government to pay the cost of reclaiming the lands along the rivers.

The present situation in regard to inland-river navigation in the Middle West may be briefly summarized as follows: The Government has spent an enormous sum, amounting to probably over $200,000,000, on the improvement for navigation of the Mississippi River and its tributaries, but the traffic on these rivers has in many cases entirely disappeared and on hardly a single one is there traffic enough at the present time to justify the expenditure that the Government has made on its improvement. Further, there are no signs whatever that river traffic is to increase in the future. On the contrary, there is a steady falling off year by year. It is admitted by the more intelligent advocates of river improvement that the chief cause of the falling off of river traffic on the inland waterways of the West is not the inadequacy of the channels that the Government has improved, but other causes with which the Government has nothing to do.

There is room for fair difference of opinion as to whether certain inland rivers most favorably situated may not in time, through changes in conditions, become of some value for navigation; but as to the Missouri River below Kansas City there can be no question in the engineering profession but that Colonel Deakyne's opinion is sound.

It may be of interest to briefly summarize a few important facts regarding this stream. The length of the river from Kansas City to its mouth is 392 miles, and in that distance the river falls 325 ft. The river winds through alluvial bottoms for nearly the whole distance and frequently changes its channel. One such change was noted in these columns only a few weeks ago. Including the distance from the mouth of the river to St. Louis, the steamboat route between Kansas City and St. Louis is nearly 420 miles long, whereas the rail distance between the same points is only about 290 miles. The Government has expended over $11,600,000 on this stretch of the river, of which about $5,000,000 has been spent in the last five years. Although numerous steamboats navigated the river in the pioneer days before the advent of railways, steamboat traffic on the river was abandoned many years ago, and the Government, after systematic work to improve the river from 1884 to 1902, abandoned the work. In the River and Harbor Act of 1912, however, Congress adopted a project for improvement of the river below Kansas City at an estimated cost of $20,000,000 to be completed in ten years. This appropriation was due to the energetic campaign which was engineered about that time for Government appropriations for inland rivers.

In order to back up this appropriation with at least a semblance of business on the river, a company was organized in Kansas City to run steamers between that place and St. Louis and great claims were made as to the enormous business which the company would carry on and the great saving which would accrue to commerce by reason of the revival of river navigation. It is of interest to compare this promised performance with the actual result as stated by Colonel Deakyne in his report published in the issue of Aug. 26. He states that the total river traffic on the lower Missouri in the last fiscal year was 37,551 tons carried distances of 8 to 290 miles at a total freight charge of $41,000. If there were any sound basis for the claims of economic advantage in river transportation, certainly the steamers that have been in service on the Missouri River ought to have made a far better showing in the last two years.

The river advocates, of course, will claim that the reason why traffic does not seek the river is that the present channel is inadequate. It is not possible, however, within the limits of any reasonable expenditure to make of the lower Missouri River a navigable channel that will be safe and commodious for vessels at all seasons. The $20,000,000 which the Government proposed to spend on the present project would not secure such a channel. With that amount spent, the river channel would still be far inferior for navigation to that of the Mississippi River, where, as is well known, the river traffic dwindles rapidly year by year.

It is altogether probable that the time has come when the Government will have to abandon its long-established policy of spending money ostensibly to improve navigation

on inland rivers, but actually to enable the local congressman to go home with a story of the appropriations he has secured to be spent within his own district. In the immediate future the Federal Government will have no money to spare for pork-barrel river and harbor appopriations. Expenditures are now running far ahead of revenue. At the coming session of Congress there will doubtless be largely increased appropriations for national defense. Increased Federal taxation will probably be necessary anyway, and with this will come a general public demand that expenditure by the Government on unprofitable enterprises shall be stopped.

Excess Condemnation Proposed in New Jersey

Excess condemnation, or taking more land than is to be used for a public improvement and selling the excess after the improvement is completed, facilitates many classes of work with which the engineer has to do. The practice is rare in the United States, because without specific state constitutional authorization it is generally held that excess land purchases for resale are not purchases for public use. A few states have recently adopted excess-condemnation amendments to their constitution, and on Nov. 2 one already passed by the New Jersey legislature will go before the people of that state. It reads as follows:

> The Legislature may authorize the state, or counties, cities, towns, boroughs or other municipalities, or any board, governing body or commission of the same, to take more land and property than is needed for actual construction in the laying out, widening, extending or relocating the parks, public places, highways or streets; provided, however, that the additional lands and properties so authorized to be taken shall be no more than sufficient to form suitable building sites abutting on such park, public place, highway or street. After so much of the land or property taken has been appropriated for such park, public place, highway or street as is needed therefor, the remainder may be sold or leased and reasonable restrictions imposed.

The aim and effect of this and similar constitutional amendments is to save a city or other governing body from paying the full value of an entire lot for a fraction of it, and perhaps a small fraction at that. Excess condemnation also enables the public buyer to recombine and sell fractional lots resulting from a land taking, gaining for itself a part of the enhanced value due to the improvement for which land is primarily being condemned and thus reducing the cost of the improvement. In conclusion, excess condemnation gives the public purchaser more or less control of the character of the improvements abutting on a boulevard, public square or park.

Concrete Pressure in Forms

The question of the pressure of concrete in forms is by no means as fully explored as desirable. Practice is well ahead of the range of experiment or well-founded formula. Pouring concrete in massive structures to about 30 ft. depth in a day's run has been done on both the Brooklyn-Brighton and the Detroit-Superior viaducts, the former case being noted in last week's issue. But measurements of pressure do not go to such depths, and no one knows reasonably closely what the pressures on the forms are in such cases. The depth of pour at which transmission of pressure begins to be interfered with is estimated variously by different persons, from 2 hr. pouring depth to 5 hr.

Usually it is assumed that concrete pressure is exactly the same in character as hydrostatic pressure. If so, then an arch ring of 50 ft. rise should, if concreted within a shorter time than that required for a set sufficient to destroy the hydrostatic character, exert an outward pressure upon the forms at the skewbacks corresponding to 50 ft. head, or 5,000 to 6,000 lb. per sq.ft. This is so great a pressure that it would be hard to hold with anything in the way of form ties now in use. Arch rings of nearly this rise have been concreted—most of the rise in half a day—without the use of forms having such enormous strength. Was the pressure reduced not only by set but also by friction in the forms? Is "liquid" concrete really semigranular material rather than a fluid?

Arch work in concrete has developed with the general progress of the concrete industry. Not very long ago the construction of a 150-ft. concrete arch gave rise to elaborate planning and preparation of drawings to guide the contractor in sectionalizing the concreting of the arch ring. The concreting extended over many days; the several ring sections were bulkheaded off and keyed, the reinforcement was spliced at the key blocks, and a very complex job was made of the whole. Nowadays such a ring is likely to be concreted in one day's run, and the elaborate sectionalizing is unnecessary. The resulting advantages are such as to invite consideration of the same procedure for much larger arches. The cost of installing the extra plant for mixing and placing would doubtless be well repaid by the saving in labor, expense and delay.

The question of liquid concrete pressure in an arch ring may therefore become an immediate practical question in the near future. Present experimental study does not furnish an answer. Further research is needed, based on a well-devised plan of experiment and carried out by able investigators. Possibly such a body as the American Concrete Institute might initiate the work and provide the means.

The Delayed Bidder's Case

An intending bidder who fails to get his bid in on time is not entitled to submit a late bid, even though his delay was due to an act of God. The question came up a few weeks ago in connection with a rapid-transit contract in New York City.

The Public Service Commission received bids closing Aug. 4 at 12:15 p.m. for certain station finish. The preceding night had been one of remarkably heavy rain. After the bids closed a representative of the Marble Arch Co. appeared and offered to submit a bid, stating that he had been held up by the rainstorm and by a block on the subway. The offer was refused. On opening the bids the lowest bid was computed at $268,102.50. Later the Marble Arch Co. served notice to show cause why a writ of mandamus should not issue, directing the commission to accept his bid, stating that it was lower than the lowest of the bids opened. The subsequent decision of the court on this question was to uphold the action of the commission in rejecting the offer to submit a late bid, in spite of the fact that the applicant set forth a detailed account of his difficulties in reaching the office of the commission.

The decision of the court is in accord with the dictates of common sense; had the outcome been different all sorts of peculiar situations might arise in the future to harass the commission and delay construction.

⁂

An opinion of the United States Supreme Court on the once hotly debated question of enhanced value of water or gas mains because of improved paving over them is sure to arouse interest. In the recently announced Des Moines 90c. gas case is a finding in this matter which will meet the hearty approval of many, and perhaps of most, engineers. The court makes no comments of its own, but accepts and promulgates the statement of a master-in-chancery for the court below. The master decided that the life of mains was not increased by the need for removing new paving when the mains had to be taken up, that the owners of the mains had acquired no property right in the paving, and that there was no justice or equity in increasing the price of gas because the company might have the replace the pavement.

This same case is of timely interest, as it gives a forecast of the court's decision in the Passaic 90c. gas case, which has attracted great attention for two years. From what has been published in these columns (Jan. 21, June 17, and July 1, 1915) it will be recalled that the New Jersey Public Utility Commissioners in appraising the property of the Public Service Gas Co. refused any substantial value for franchises and the State Supreme Court upheld them. The Court of Errors and Appeals first reversed the Supreme Court (taking the ground that franchises were company property and that the value was indicated by the market value of the company's securities) and later reversed itself (one judge explaining that franchises were property, but not "property used and useful in the public service"). The case is now before the United States Supreme Court on appeal. The Des Moines decision does not touch upon franchise value specifically, but it dismisses value for good will, past earnings and paving over old mains. The next consistent step will be a general denial of franchise value—beyond that due to cost and burden. Such an authoritative pronouncement on what to include in the basis of rates will clear away the haze that now involves this matter.

⁂

Word comes from Philadelphia that the "voluntary installation of [water] meters is proceeding at an unexpected rate." Moreover, incentive being offered by the water bureau led the *Bulletin* to declare that "the 2 per cent. of the service which is now metered ought to show considerable expansion" in September. Evidently the "unexpected rate" has not been maintained long or would be "unexpected" only in Philadelphia. Seriously, any noticeable acceleration in the installation of water meters in Philadelphia is encouraging.

Letters to the Editor

Should Another Course Be Added to the Engineering Schools' Curriculum

Sir—The latest progress report of the special committee of the American Society of Civil Engineers appointed to investigate the conditions of employment and compensation of civil engineers shows among other things that the average compensation of nongraduates with from two to fifteen years' experience exceeds that of graduates with the same amount of experience. A still greater discrepancy in favor of the nongraduates would undoubtedly be found if engineers outside the membership of the society were studied, as then more of the younger graduates would be included.

This is owing, no doubt, to the lack of field experience in the young graduate and to the results which the nongraduate can secure with his practical knowledge. The condition disclosed by the committee's report is due, in a large measure, to the technical school. The curriculum rightly embraces theories and underlying principles, but it does not include in any adequate measure the art of applying these principles and theories to practical use.

The engineering student devotes hours to descriptive geometry and calculus, but can he cut out a pattern by which an elliptical sheet-metal pipe can be made which will fit a hypocycloid of revolution at any given angle, if such should be required on his first job? He can draw detailed plans for a timber roof on an ordinary dwelling house, but can he show the carpenter how to cut a jack rafter to fit the hip rafter? He can design a 100-ft. plate girder down to the last rivet, but does he know the first thing about how to place it upon its abutments, or how to build them? In most cases, No.

It will be argued that designing and constructing are in entirely different fields. That is true, but a man is a better designer if he knows the erecting end. His detailing of connections, etc., will be better if he is able to view them from the standpoint of the man in the field who has to erect. *Vice versa*, the construction man will do better work if he is conversant with designing methods and principles. Every construction engineer has repeatedly come across details in plans which have either been impossible or expensive. Most of them would have been obviated had practical experience been combined with theoretical instruction.

About a year ago the writer was asked to address a student engineering society, and in conversation with one of the young men interested, intimated a desire to speak upon "What do you know at graduation." When an explanation was sought, the reply took the form of a hypothetical question: "Suppose you had to erect a 100-ft. steel flagpole, lay the necessary foundation and place the guys and guy anchors. You could, no doubt, compute the size of the pole necessary to take care of all possible wind stresses and to meet all other conditions. You could calculate the sizes of the guys and the weight of anchorage necessary and the number of yards of con-

crete to form the anchorages and foundation. But how would you put the pole up in the air? Could you say how many barrels of cement, how many cubic yards of sand and of gravel would be necessary to make the concrete?" The young man saw the point, for he did not know the first thing about the raising of the pole. Yet a man with two years of experience (the equivalent to a degree in the American Society requirements for admission) on construction work would probably have answered at once.

Technical colleges, of course, are not intended to turn out finished and thoroughly competent engineers. But they should not graduate men, as they do, who know nothing whatever of the tools, equipment and methods of construction. Graduates are put forth upon an unsuspecting world who do not even know the names of many of the tools and much of the equipment with which they have to deal; they have only a hazy idea of the way work is done and practically nothing of the unit costs of such work.

The direct cause of this condition is perhaps the fact that instructors and professors, in general, are men with very limited construction experience. Many have devoted practically all their time since graduation to the classroom; they are well-grounded in theory and quite naturally deficient in its application, so that they fail to see the importance of the construction side of engineering.

It seems to the writer that, as a remedy, a course in engineering construction might be a very desirable adjunct to the curriculum of the technical college. A chair of this sort should be filled by a man who is well-grounded in theory and who has had a fairly extensive experience in actual construction of engineering works of the class which the graduate would be most likely to encounter early in his career.

The course should embrace the ordinary construction which the young engineer might be called upon to plan and supervise—such as all classes of concrete work, excavation, foundations, sewers, water-works, pavements, buildings and bridges. It should also include falsework, rigging, etc. The student should be acquainted with the field for various kinds of tools from pick and shovel up and should be given instruction as to when and how to use them. Next should come the kinds and uses of the various power equipment. He should be taught how to tie knots and to rig derricks, hoists and such equipment.

Methods of doing various classes of work might be taken up in the classroom. Instruction would probably be given as to what equipment to use in specific cases, such as, for example, dry-earth excavation under various conditions, excavations in wet earth, in rock, under water, in quicksand. The temporary works necessary, such as sheetpiling, falsework, coffer-dams, forms and underpinning, would also be studied. Quantity surveying should also be included, both for the finished structure and for all temporary works. Unit costs of the more common elements under varying conditions might well be added; this should also include cost accounting and distribution. The instructor, from time to time, could introduce new features, such as floods, storms, etc., which would correspond with actual unforeseen contingencies.

As a summation, problems should be given which would combine all these; for example, a concrete-arch bridge is to be constructed from plans furnished. The foundations at one end are 10 ft. below the water level and in treacherous soil requiring piling; at the other end solid rock is encountered. The student should work out the problem from the knowledge he may have previously gained. He should first, perhaps, outline the methods by which he would do the work. In other words, he should design his construction plant. This would include making a list of all the tools and equipment that he would deem necessary, as well as of all material for the construction and assembling of the plant. Next would come a bill of material for the entire job from inception to completion. An outline of the various steps in the progress of the work would be in order, together with the methods to be used in each case. In short, the student should plan the work just as an experienced man would do if he had to do the work in the heart of Africa—with no convenient base from which deficiencies might be supplied. Of course, the student could not do this as well as an experienced man could, but he would do better than he could if he had had no previous instruction. As a finality, an estimate of cost and time should be prepared.

Work of this nature could probably best be given by lecture courses, supplemented by visits whenever possible to scenes of work in progress. Students should be urged to secure positions—or merely "jobs"—on construction works during the summer vacations, for which credits should be given. A young man with pick and shovel, if he keeps his eyes open, can learn a great deal in one summer.

A course of this nature, as roughly outlined, would undoubtedly prove to be one of the most interesting and popular, as well as beneficial, in the entire curriculum, and deservedly so. It would also do much toward securing better initial salaries for the graduate.

The writer is not attempting to disparage the teaching of theory, nor advocating the transformation of our technical schools into mere trade schools. He is appealing for a happy medium in combining theory and application, believing that such a combination would benefit both school and graduate, and eliminate much of the criticism of the product now placed upon the market.

R. C. HARDMAN.

Colorado Springs, Colo.

[We give space to Mr. Hardman's letter because it represents a type of criticism of the technical school which one frequently hears, but for which there is perhaps less justification than many suppose. A number of the technical schools are attempting to give just such practical instruction as our correspondent proposes, and have long done so. One member of the editorial staff of this journal, for example, recalls being given as a freshman in Cornell, fifteen years ago, the identical problem as to the practical method of erecting a flagpole which our correspondent suggests. The real trouble with our technical schools, as we see it, is that through a misinterpretation of such criticisms as that of our correspondent they have loaded up their courses with a mass of technical detail and have multiplied courses and specialized instruction, so that the tendency is toward the production of specialists rather than all-around engineers. But in imparting fundamental knowledge and giving rudimentary training the practical side can be emphasized more successfully than now is generally done.

There is a limit to the amount of information one can cram into a youth in four years; and he ought to get out of his college course a development of character and personality that he may miss if he has to grind on purely technical studies all the time.

It is obvious, however, that detail instruction on field and shop and office methods in all the various branches is attempting the impossible. How many engineers of ten years' experience have any practical knowledge of construction work and methods outside the fields in which they have been directly engaged? Suppose it were attempted to make students in their four-year course familiar with the construction methods now in use "in all classes of concrete work, excavation, foundations, sewers, water-works, pavements, buildings, bridges, etc."—we quote the list from our correspondent's letter. There is enough in this list alone to consume all the time of a four-year course, and this of course is only a beginning in enumerating the different fields of work in which a civil engineer may engage.

The real trouble, it seems to us, lies in the fact that the engineering schools are expected to turn out *engineers* at graduation, whereas their aim should be to turn out men so well-grounded in the fundamental principles and methods applicable to all sorts of engineering work that they will have this knowledge and ability as an aid in whatever sort of engineering work chance directs them toward—for in nine cases out of ten, it is chance, and not specialization in college studies, that determines in what sort of engineering work a graduate will find employment.

We would not be understood, however, as urging that engineering instruction should be purely theoretical. All the subjects in an engineering school should be taught as *applied* science; and the ability to apply it is as important as the science.

What does seem to us objectionable is attempting to teach in an engineering school a lot of detail relating to special fields of engineering work, which the student will never use unless he chances to fall into that particular field. It is said of course that such instruction is useful mental training, but it should not be forgotten that there is an elastic limit to the mental machinery of the students. The world is afflicted nowadays with societies devoted to almost every subject under the sun, but there may yet be room for a society for the Prevention of Cruelty to Engineering Students.—Editor.]

Engineering-Society Publicity

Sir—I read with much interest F. H. Newell's letter on "Public Speaking for Engineers," in *Engineering News* of Aug. 5, 1915. Mr. Newell rightly places much emphasis on the importance of engineering publicity, which has been woefully neglected by the profession. Not only has the young graduate engineer a marked lack of self-expression; the older engineers are guilty to a large extent of the same disability.

It is my opinion that the self-centered aloofness of the engineer and his hesitancy to discuss matters of public interest and welfare without remuneration has been one of the causes of failure on the part of the public to appreciate the importance of the engineer and to make proper recognition of the profession.

A rough outline of a scheme of publicity for local or sectional engineering societies which would lead to very desirable results in elevating the plane of the engineer as a professional man and in benefiting the individual members of the society is here suggested.

Publicity committees composed of men proficient in their respective branches of engineering would be elected or appointed for a term of three to six months (depending on the number of members, the idea being to give all members a chance to serve on such work). The duties of these committees would be to keep in touch, through the aid of the secretary, with questions of public interest and to prepare and submit articles on these questions to the various newspapers in the city and vicinity; also to report on disasters or accidents related to engineering. Of course such matter should be written in language readily understood by the average reader.

The various engineering societies should become active in publicity work in order that we may be freed from the sensational, untruthful and harmful reports on accidents to engineering works so common in the daily press.

ALBERT M. WOLF.

Chicago, Sept. 4, 1915.

The Flat-Slab Patent Suit

Sir—I note in your issue of Aug. 19, 1915, p. 379, you publish a statement relative to the contempt proceedings in Minneapolis, in the case of the alleged infringement of the Norcross patent for concrete flat slabs. That statement was not complete.

Judge Morris, who decided the matter, said that he considered it was up to the Court of Appeals to decide the scope of the Norcross claims and he did not understand clearly how the ruling which he was bound by was consistent with the state of the art. For that reason he decided to fine me nominally $200, not to be paid until after the matter was passed upon by the Court of Appeals, and that this fine was made payable into the United States Treasury in order that an appeal to the Court of Appeals would lie and the matter could be more fully threshed out by it.

C. A. P. TURNER.

Minneapolis, Minn., Aug. 27, 1915.

NOTES AND QUERIES

Errata—W. G. Peters, Deputy County Engineer, Chehalis, Lewis County, Wash., sends the following corrections to the "Table of Square Feet Reduced to Decimals of an Acre," p. 363, "Engineering News," Aug. 19, 1915:

510 sq.ft.	reading 0.0171	should read 0.01171
27,200 sq.ft.	reading 0.62242	should read 0.62442
35,700 sq.ft.	reading 0.81596	should read 0.81956
42,700 sq.ft.	reading 0.98206	should read 0.98026

The Paddle Wheel as a Pump—In response to the inquiry, in this column of the issue of Sept. 9, about scoop wheels built and used in this country, John H. Cook, Hydraulic Engineer, 158 Ellison St., Paterson, N. J., writes that there is a paddle wheel that is used as a pump at the Morris Canal and Banking Co.'s station on the Hackensack River, not far from the Newark Plank Road in Jersey City. This wheel is about 12 ft. across the breast and is operated by an old walking-beam engine that was built about the year 1856. The water is lifted about 5 ft.

Water-Pocketing in Two-Angle Members—This is urged by A. R. Astbury, Provincial Executive Engineer, Winterfield, Simla, against such a design of member. In light pony-truss highway bridges, where extreme lightness and compactness are necessary on account of pack transportation (weight limit 150 lb., length limit 12 ft.), the two-angle member with angles spread enough to take the gusset-plate is economical, but rapid rusting is feared from water-pocketing between angles. Suitable designs would be appreciated.

Measuring Drainability of Imhoff Tank Sludge*

The thorough digestion of organic matter in the sludge compartment of a mature Emscher tank results in a destruction of the sticky colloidal matters, a breaking down of organized bodies into finely divided particles, and a material reduction both in the volume of the sludge and in its percentage of moisture. It also causes the presence of gas, which is compressed when the sludge is in the bottom of the tank, but which expands when reduced to normal pressure as the sludge is withdrawn.

This expansion causes the solid portion of the sludge to float upon the water, which, owing to the conditions described, very rapidly separates at the bottom. For these reasons such sludge, applied to underdrained sand beds, will dry sufficiently to be removed in a few days instead of probably weeks or months with other kinds of sludge.

The methods of sludge analysis in most common use consist in determining the percentage moisture and specific gravity of the wet mass and the percentage of the dry residue that is fixed and that which is fat or soluble in ether. These tests are principally of value to show, in an indirect way, the good or bad qualities of the sludge, and it seems that an additional test is required to measure drainability.

The real and essential properties of sludge, when it must be disposed of on land adjacent to habitations, are odor, volume and drainability. I am not acquainted with any better apparatus than the nose for determining the first, a foot-rule for the second, and for the third the results of a few experiments are here offered in the hope that from them a simple test may be devised.

Since April of this year a composite sample of each batch of sludge placed on the drying beds at the Pennypack Creek sewage-disposal works (Philadelphia) has been submitted to the two following procedures:

A portion amounting to 700 c.c. is placed in a 1,000-c.c. measuring cylinder and the amount of clear water separated at the bottom observed and recorded at hourly intervals. This is continued until the sludge begins to settle down into the water again.

Another 700-c.c. portion is placed in a vertical piece of glass tubing of the same internal diameter as the measuring cylinder. Over the lower end of the tube is secured a piece of wire screen which supports a ½-in. layer of small pebbles, a ½-in. layer of clean Jersey gravel, and a 2-in. layer of fine sand. (The thickness of these layers could probably be reduced and thereby decrease the amount of entrained drain water.)

The tube is held in a retort stand over a funnel resting in a measuring cylinder to collect the water draining out of the sludge, and the accumulated amount of water is read at hourly intervals until the sludge ceases to drain. The results of these measurements are plotted in terms of c.c. of separated water and time.

In several instances the sludge placed in the measuring cylinder has begun to float on the water, after a few hours settled down, then separated and floated again. Such action prevents obtaining a useful curve of drainability, and it appears that the tube with filtering media is the better method.

*Condensed from a paper presented to the Sanitary Engineering Section of the American Public Health Association, Rochester, N. Y., September, 1914, by W. L. Stevenson, Assistant Engineer, Sewage Disposal, Philadelphia.

An examination of the curves [not here reproduced—Editor] indicates that the factors which should be combined to obtain a number to represent the drainability of the sludge are:

a. The rate of drainage represented by the slope of the first part of the curve.

b. The ratio between the amount of water drained from a liter of sludge and the amount of moisture therein as determined by the usual evaporation method.

c. The time required for the water to begin to drain out.

Good sludge will be indicated by (a) having a steep slope, (b) showing a large number for the ratio, and (c) showing a short time; bad sludge the reverse.

No attempts have been made to combine these three factors to form a number similar to the relative-stability figure for filter effluents, because the data are too meager and only sludge from one works treating a sewage which is two-thirds institutional has been used in the experiments. But I believe that more extended study in some of the sewage-works or testing-station laboratories might develop a simple field test capable of being made by the type of operator usually found in the smaller works and that its use would serve to indicate a very important characteristic of Emscher tank sludge.

Convention of the New England Water-Works Association

The 34th annual convention of the New England Water-Works Association was held in New York City, Sept. 7-9. The registration was well over 600, and all the meetings were fairly well attended considering the many other attractions in the city and the extreme heat of the weather. Following the usual addresses of welcome and other preliminaries, the following subjects were discussed:

New York City Water-Works

The water-supply and water-works of New York City were naturally subjects of much interest. The present status of the new Catskill water-supply was described by J. Waldo Smith, Chief Engineer of the Board of Water-Supply. This work is rapidly nearing completion and another spring will see its real test in service. Mr. Smith frankly stated that because of the much new and unprecedented construction he expected to find that details would have to be revised and changes made before reaching an entirely satisfactory conclusion of the work.

The sanitation of the Catskill watershed was described by George H. Honness, Department Engineer of the Board of Water-Supply, and the forestation of the watershed was described by Sidney K. Clapp, Assistant Engineer of the Board of Water-Supply. Mr. Clapp's paper was unusual in the wealth of detail given; it covered the gathering of the seeds, planting, keeping off birds and mice, preventing mildew, exterminating grubs and field mice, and precautions against winter killing of the young trees. The forestation work of the Board of Water-Supply is more for landscape work than in expectation of utilizing the trees later for commercial purposes.

The forestation of the Croton watershed was the subject of a paper by T. C. Culyer, Assistant Engineer, Department of Water-Supply, Gas and Electricity. The concrete wire-fence posts used in the Catskill drainage areas were described by Ralph N. Wheeler, Department Engineer, Board of Water-Supply.

The Kensico dam and reservoir were described by Wilson Fitch Smith, Division Engineer, Board of Water-

Supply, and a very enjoyable excursion was made to the dam Sept. 9. Although the temperature on that day was around 90 deg., a large party took the special train to Valhalla and toiled up the hill to the top of the dam. Very few, however, could be induced to visit the quarry, which is about a mile from the dam.

The water-supplies of some Long Island sections of the city were described in considerable detail by W. F. Laase, Assistant Engineer, Department of Water-Supply, Gas and Electricity, in a paper, "Infiltration Galleries as a Source of Water-Supply on Long Island."

The laying of water pipe in the congested streets of the city was the subject of a paper by M. Blatt, Assistant Engineer, Department of Water-Supply, Gas and Electricity. As a typical instance Mr. Blatt described the installation of the downtown high pressure fire-protection mains. No records of subsurface structures were available when the work was started, and it was first attempted to obtain a plan of these pipes and conduits by digging test pits at intervals. Subsequent experience proved this was not feasible, and the work was carried on without knowledge of the subsurface conditions to be met, except such as could be obtained from test pits immediately in advance of the trenching. Much reconstruction of existing structures was required before room could be found for the new mains.

The electric operation of valves on the high-pressure fire-protection system was described by Alfred Williamson, Mechanical Engineer, Department of Water-Supply, Gas and Electricity.

The locating of a leak in a 12-in. submarine main crossing to Riker's and North Brother Islands was described in a paper by E. G. Hooper, Assistant Engineer, Department of Water-Supply, Gas and Electricity. The chief feature in the method used was the determination of the hydraulic gradients on different parts of the line by means of pressure gages; the point where the gradient shifted, being the place where the velocity changed, denoted the vicinity of the leak.

Water-Supplies of Other Cities

The double sand filtration plant for the purification of the water-supply of South Norwalk, Conn., built about 7 yr. ago, was described by H. W. Clark, Chemist, Massachusetts State Board of Health. This plant, according to Allen Hazen, is the most complete in this country for the removal of tastes and odors. Portions of the water treated, Mr. Clark said, are sometimes about the color and consistency of thick pea soup. No difficulties have developed in its operation. The interest on the $100,000 investment and the cost of operation amount to about $10,500 per annum.

A joint additional water-supply for the cities of Salem and Beverly, Mass., was the subject of a paper by F. F. Longley, New York City. The most interesting features of this work were the survey of a 9,000-acre swamp and the building of a canal through this swamp from the Ipswich River to a pumping station near the present reservoir. The canal was so feasible that it was built instead of a pipe line as first proposed.

Recent improvements to the water-supply of Fall River, Mass., were described in great detail by H. K. Barrows, Boston, Mass. Here water is taken from a natural pond close to the city, which contains only a limited supply. The pumping plant is an old one and as not sufficient storage is provided for a single day's supply (5,600,000 gal.), the city has not much margin of safety. The improvements noted were the establishment of an independent electrically operated pumping station for emergency use and the improvement of the water-supply itself by the gradual acquirement of the watershed by the city. The greater part of the paper was a detail description of the construction of a covered reinforced-concrete drain.

Water-Main Joints—Use of Leadite

The use of leadite for water-main joints was the subject of two papers—one by Henry A. Symonds, Consulting Engineer, Hanscom Construction Co., Boston, Mass., and the other by W. C. Hawley, Chief Engineer and Superintendent, Pennsylvania Water Co., Wilkinsburg, Penn. Both were in favor of the use of leadite. Mr. Symonds emphasized the necessity of skilled labor. Practically the only unsatisfactory experience he had had was on sharp curves, where the thin wedge of leadite broke out in some instances. However, he stated that he believed satisfactory results could be obtained with proper care under any and all conditions. Mr. Hawley said his earliest experience with leadite was unsatisfactory, but that now after nine years' trial he had come to use it exclusively; some failures he believed were caused by improper manipulation of the material and some by collusion among the calkers, who would be thrown out of employment if leadite was adopted. He laid considerable stress on the effect of leadite in preventing electrolysis. A. E. Martin, Superintendent of Water-Works of Springfield, Mass., and other speakers gave their experiences, in which it was brought out that although leadite joints sometimes show leakage at first, generally within 24 hr. they become watertight.

Leakage from lead-jointed mains was discussed by Arthur H. Smith, Engineer of the Associated Factory Mutual Fire Insurance Companies, Boston, Mass. This paper contained a valuable compilation of data from a variety of sources, from which the author drew the conclusion that water-tightness was an impossibility and that a leakage of 1 gal. per day per lin.-ft. of joint was to be expected in good and acceptable work. Many instances were quoted where existing mains show a much larger leakage. It was generally agreed that all mains should be fully tested for water-tightness of the joints before acceptance, but that in few cases was this feasible before the pipe trench was backfilled, although this was preferable. Deferring the backfilling to know if the joints were water-tight does not seem to be general practice except where the work is in outlying districts. It was also questioned whether it was good policy to leave the pipe uncovered any length of time, as the increased effects of temperature changes led to expansion and contraction and the opening of joints.

The need of a standard to determine just what leakage should be allowed was keenly felt and upon the motion of William F. Sullivan, Engineer and Superintendent, Pennichuck Water-Works, Nashua, N. H., a motion was passed to have the president appoint a committee to investigate this subject.

Experience with Water-Main Gate Valves

An interesting discussion of gate valves was started by two papers—one by Geo. H. Finneran, Assistant Superintendent of Water Service, Boston, Mass., on the reasons for adopting the solid-wedge type of valve in Boston,

and the other by John M. Diven, Superintendent of Water-Works, Troy, N. Y., on the reasons for using the double-disk valve. In Boston solid-wedge valves have been used since 1848, when the present water-works were begun. The city has its own shops, where all these valves under 12 in. in size are made. Mr. Sullivan believed the governing consideration was mechanical simplicity, and as the solid-wedge valves possessed this virtue and had always given satisfactory service, there was no reason for abandoning their use. Mr. Diven based his arguments in favor of double-disk valves chiefly on the fact that manufacturers have practically abandoned the manufacture of any but this type and that the most popular type must be *per se* the best type. Much interesting information in regard to the actual wear of valves was brought out in the discussion. The manufacturers of valves were given the privilege of the floor, but none availed himself of it.

Miscellaneous Subjects—Meter Testing, Etc.

The work of the New York City Department of Water-Supply, Gas and Electricity in developing tests for meters was described by F. B. Nelson, Assistant Engineer of the Department. The city of New York does not own water meters, but any water consumer may purchase a meter and pay for his water in that way if he so desires. The point emphasized in Mr. Nelson's paper was that meters of different makes for the same-sized service vary a great deal in capacity (64%) and an attempt is being made to rate them by taking this into account.

The control of public water-supplies by the Conservation Commission of New York State was the subject of a paper by Russell Suter, Assistant Civil Engineer of the Commission, Albany, N. Y.

The results of a study of data collected chiefly in connection with the Metropolitan Water-Works of Massachusetts on the decolorization of water by storage were given by Ralph H. Stearns, Boston, Mass. Although Mr. Stearns had a well-developed theory, this was questioned by several speakers. Allen Hazen pointed out that there were so many uncertain elements entering into the problem that it was difficult to arrive at any general conclusions.

The use of wood pipe generally, and in New Hampshire in particular, was described in a paper by A. W. Dudley, Consulting Engineer, Manchester, N. H.

Association Business Transacted

The most important business transacted was the appointment by the president of a committee to investigate and tabulate leakage of water-main joints, with the end in view of establishing some standard of water-tightness for both old and new mains. The committee appointed is F. A. Barbour, Consulting Engineer, Boston, Mass.; Carleton E. Davis, Chief of the Bureau of Water of Philadelphia; Samuel E. Killam, Superintendent of Pipe Lines and Reservoirs, Metropolitan Water-Works, Boston, Mass.; Caleb Mills Saville, Chief Engineer of the Board of Water Commissioners of Hartford, Conn.; Henry B. Machen, Borough Engineer, Department of Water Supply, Gas and Electricity, New York City, and Arthur H. Smith, Engineer, Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

Three past-presidents of the association were elected to honorary membership. They are Edwin C. Brooks, of Melrose, Mass., former Superintendent of Water-Works of Cambridge, Mass.; George A. Stacy, Superintendent of Water-Works of Marlboro, Mass.; and Robert J. Thomas, Superintendent of Water-Works of Lowell, Mass.

This nominating committee to choose the officers for 1916 was appointed: F. A. McInness, Boston, Mass.; E. W. Kent, Newport, R. I.; J. Waldo Smith, New York City; E. E. Lochridge, Springfield, Mass.; A. E. Blackmer, Beverly, Mass.

It was proposed by Charles W. Sherman, Consulting Engineer, Boston, Mass., to honor the late Dexter Brackett, past-president of the association, by establishing a fund to be raised by subscription, the income of which might be used as a prize for papers, for research work, or any other purpose that the executive committee might decide upon.

Awakening of the Engineer*

By F. H. Newell†

Now is the day of awakening of the engineer as a man and as a citizen to a larger realization of his duty to society in general, to his profession, and to himself in particular. He is not alone in this. A world-wide war has shocked into new life many dormant conceptions and has opened the eyes of mankind to the larger claims of brotherhood.

The quality that distinguishes the engineer as a professional man from his brother the mechanic is education. The engineer is undoubtedly benefited if at the same time he is a good mechanic, although he may be a success even if he has little or no mechanical ability. To be an engineer in the true sense, he must have, however, that education which enables him to understand the true perspective of things, to know the big from the little, to obtain facts and judge correctly from these.

What is the service which all engineers should be eager to render and which is the fruition of years of training? What do we mean when we claim that the highest function of the engineer and his greatest reward are found in effective service? The word conveys the idea of help rendered to another, not as a favor involving an obligation, nor on the other hand as a matter of self-sacrifice. It is something that may be expected though it cannot be demanded, and may be performed among equals. Service consists of those acts that tend to lessen trouble or increase the health, prosperity and convenience of others.

Engineers in performing service are by this very fact entitled to full recognition. Service implies a suitable reward, and while the effort may be altruistic, it does not involve unnecessary self-denial. A proper remuneration—one assuring a good living—is due to the engineer. He that performs service rightfully does it with full expectation of reward, directly or indirectly, in the satisfaction of duty well done.

Engineer's Service to the Public

Among all the various occupations there is none more capable of leading in service to mankind and in realizing higher ideals than engineering. The engineer should be a man of vision—a missionary of light and progress. His life is devoted to careful, impartial measurement and

*Extracts from an address before the American Association of Engineers, Chicago, Sept. 14, 1915.

†Professor of Civil Engineering, University of Illinois Urbana.

weighing of facts. He cannot afford to be deceived or to mislead others on these facts; having ascertained them in their true proportion, it is then his business to idealize, to plan, and to use his ingenuity in devising methods for adding to the comfort and convenience of mankind—such for example, as through better conditions of transportation, of communication, of heating, lighting, water-supply and of the things which tend to produce better health and longer life in the community.

In this work the engineer is far ahead of the public. The latter in many ways has not yet caught up with the growth of knowledge and does not appreciate the possibilities that are awaiting realization under the magic touch of the skilled engineer. The public is not wholly to blame. The engineer is to a certain extent culpable. He has not fully felt the need of diffusion of information, except among his professional brothers. He has not taken the public into his confidence and explained in simple terms, in ways that would attract the public, the results already achieved; nor has he given these a setting or application such that the ordinary citizen and taxpayer can comprehend how this work affects him or how his condition may be improved.

Engineers in North America Number 100,000

It is safe to assume that there are in North America over 100,000 men whom we would class as "engineers" outside of the purely mechanical occupations. Of these over 40,000 are members of approximately 100 organizations,[1] leaving over 60,000 men not enrolled in any engineering society.

In the great group of 60,000 are many men of ability and standing in the profession, but who have never seen the necessity of joining with their fellows in organized efforts. By far the greater part, however, are the younger or less prosperous men, who are performing routine work in engineering offices or engaged in the details of the country surveyor and engineer. As a whole, they include the more poorly paid professional men whose compensation averages less probably than that of the high-grade mechanics. We do not have any definite data on this point, but those who have employed engineers and graduates of engineering schools are aware of the fact that under present conditions at least, we can obtain the service of highly educated skilled engineers as computers, draftsmen, office or field assistants at a nominal wage.

It is not the "submerged tenth" but the six-tenths for whom special appeal should be made to ascertain whether their condition may not be improved by applying to it the same painstaking study to ascertain the facts and to provide a remedy, as should be done by the engineer to meet and overcome physical obstacles.

Widening the Field for Engineers' Work

To this large body of engineers there is being added each year about 5,000 recruits, mainly from the engineering colleges, more or less well-trained in the fundamentals of engineering. One of the problems that is now confronting us is the fact that each year this large group of graduates, as well as the thousands of young men employed in engineering offices, is coming into a profession apparently overcrowded. This overcrowding, however, is more apparent than real. A relief is to be obtained not by limiting the influx of men, but rather by widening the field of service.

The field is practically unlimited, the bounds extending with every improvement in the conditions favorable to human health, comfort and industry. Artificial limits, the cramping efforts of which we now appreciate, are set solely by ignorance. They exist only in the mind and arise because of lack of knowledge by the public in general and of individuals in particular. To put it in another way, if every taxpayer and voter in the country, every town, city, county and state officer, were fully aware of the conditions which surround him and the extent to which the engineer could remedy or improve these conditions, there would be an immediate demand for all the engineers that could be found.

To seize properly the opportunity the engineer who rises to the occasion must cultivate some of the qualities summed up in the term *salesmanship*. We recognize that the success of many a merchant is due to a peculiar art that he has acquired and one that enables him to sell goods at a profit. We have more slowly come to recognize the fact that his success is due not to the fact that he personally makes a profit, but that the other party, the world to whom he sells, is benefited. For a time a merchant may sell inferior goods and make money, but an established business can rest secure only on honest advertising and on the realization by the public that he is performing a real service to mankind.

In the same way, the engineer, to succeed, must acquire the art of salesmanship. He may not recognize or label the quality and may even deny its existence. He may point to a code of ethics rigidly observed against advertising or self-exploitation, and yet he may possess to a high degree the real art of presenting his ware in such a way as to convince the world that its general welfare is promoted by purchasing from him.

There is perhaps nothing more instructive to the young engineer than to try to ascertain the methods of salesmanship which have led to the recognition of certain well-known and respected engineers. Some have succeeded through or in spite of extreme modesty; but in each case there has been not only true value of the goods to be delivered, but some quality of mind or action that has impressed upon others the fact that the goods are of superior value.

Line of Action for Awakened Engineers

In the present awakening of engineers innumerable schemes have been suggested for action, but most of these fall under one or the other of two principal lines: (1) Coördination and coöperation of existing engineering societies and organizations; (2) formation of one or more new associations devoted almost exclusively to the material welfare of engineers. These movements are the natural outgrowth of the discussion and unrest which have prevailed. They are not antagonistic and may be mutually helpful. Not all men think alike, and the path which will be attractive to one group is not to another.

[1] The larger part of this 40,000 is included in four great national societies, the membership of which in round numbers is as follows: Civil, 7,700; Mechanical, 6,100; Mining, 5,000; Electrical, 7,750. The total of 26,550 includes many duplications, but it is safe to assume that at least 20,000 engineers, embracing most of the men who have become leaders in the profession, are included in the membership noted. The organizations next in point of size are the Engineers' Society of Western Pennsylvania, with headquarters at Pittsburgh, 1,150 members; and the Western Society of Engineers, with office in Chicago, 1,200 members; next the Associated Engineering Society of St. Louis, with 800. The hundred or more local engineering societies organized at the principal centers of population have a membership each of from 100 or less up to 500 or more, averaging about 200.

In establishing a new movement or society the burden of proof of the need of such organization is upon the promoters. If it is proposed to assume new costs and create new obligations, it must be clearly shown that there exists not only real need for this additional machinery, but that the public will be the gainer thereby.

If we go deeply, we find that in a free country no volunteer organization can long exist if it be founded on purely selfish motives. The public does not long deal with the merchant that does not give fair bargains, and it does not look with favor upon any body of men brought together for confessedly selfish ends. If, therefore, any movement should be so unfortunate as to start with the handicap of popular misconception that it is devoted solely to the financial gain of its members, its future history would likely be short and stormy. For this reason the benefits kept prominently in view should be those, not of individuals, but of society as a whole.

Summing up the needs and opportunities, it appears that a great part of the main body of engineers is not fully employed to the best advantages to society and to themselves, with corresponding loss to all. Nearly two-thirds of those who may properly call themselves engineers, or perhaps 60,000 men, are not members of any well-recognized organization, and are not utilizing their potential strength to help themselves or one another. There is need of enlightenment, of raising ideals and of united effort toward better things. The existing engineering organizations, which include perhaps 40,000 men, are devoted almost exclusively to technical questions as distinct from those things that concern the engineer as an individual and a citizen. Few of the older societies attempt to bring in the rank and file of the profession, or attempt to cover the field of the new American Association of Engineers in its efforts to help and reach the masses of the profession.

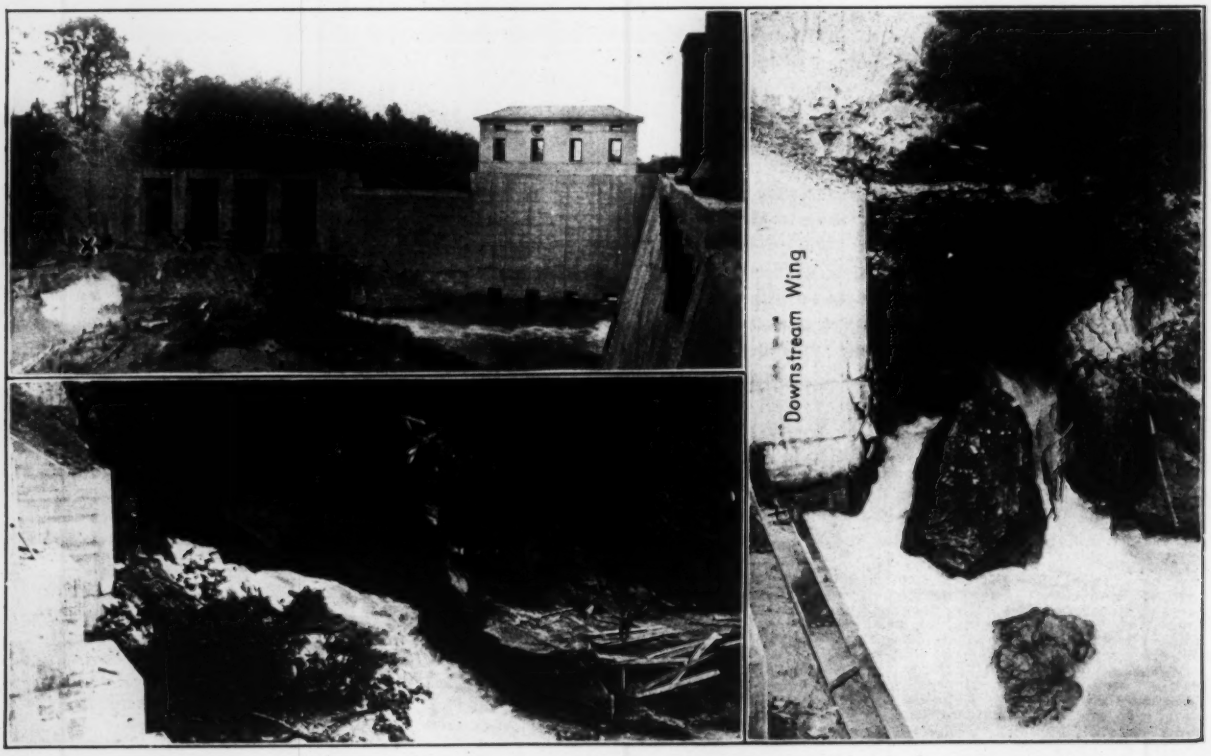
News of the Engineering World

Blowout at End of Concrete Dam, Seneca Falls, N. Y.*

A partial failure of dam No. 2 on the Cayuga & Seneca Canal, about a mile below the village of Seneca Falls, N. Y., occurred Sept. 3. The failure was caused by leakage around the end of one abutment and cutoff wall. This dam is part of the New York State Barge Canal system, and was built to mantain a 4-mi. level to Waterloo.

The dam is about 475 ft. long and is made up of an earth-filled section on the south end, a pair of twin locks in the center and a solid concrete section on the north end. The part of the canal immediately above the dam spreads out and forms an artificial lake 1,500 ft. wide.

*Information furnished by Reed W. Cady, Civil Engineer, Seneca Falls, N. Y.



BLOWOUT AT END OF CONCRETE DAM, CAYUGA & SENECA CANAL, SENECA FALLS, N. Y.
Cross in upper left-hand view shows upstream end of blowout; other views show downstream end

The break occurred at the north end of the concrete part of the dam, where the original surface was an abrupt outcrop of soft shale with occasional strata of a harder, somewhat porous rock. A cutoff wall was carried into this bank 50 ft. from the original surface, which at the time was thought sufficient, although the porous nature of the material was known.

The dam was completed and the canal level filled on Aug. 19 and 20 of this year. Seepage was noticed at once on the downstream side of the slope, but the water that came through was clear. The flow was equivalent to that from a 4-in. orifice, and apparently did not increase during the first ten days.

On Sept. 2 it was noticed that the rocks were wet for over 100 ft. downstream and that the leakage was slightly more. At 7 a.m. on the 3rd a big stream was noticed rushing from the hole just below the abutment. Responsible people were notified at once, and the boats on the canal level above were warned.

To facilitate drawing off the water the valves of the lock were opened, and by 6 p.m. of that day the head was reduced 12 ft. Some 36 hr. after the break the hole was exposed. The water had eroded a tunnel 120 ft. long around the end of the cutoff wall. This blowout varied in size from 6x8 ft. near the inlet to 12x20 ft. at the outlet. The opening on the upstream side was 30 ft. and at the outlet was 45 ft. below the original pool level. No injury was done to the dam masonry, for all the water found its way around the end and not under the concrete. Large quantities of earth and soft rock were washed from below and behind the abutment.

Plans for repairs have not been decided upon, but they will probably include building the cutoff wall farther into the hill, blanketing the upstream slope with a clay embankment or grouting the porous strata.

San Francisco Shore Protection

The design for the protection of the ocean beach alongside the new esplanade in San Francisco has just been completed, and it is announced that bids for one unit will be called for in a few weeks. As described on page 499 (Sept. 9, 1915) the esplanade is a new boulevard on the Pacific-coast side of San Francisco. In its preparation it is necessary to protect the beach against the inroads of the sea, and the wall and paving shown in the accompanying drawings are intended for that purpose.

The beach protection consists of a series of steps six in number, which will be erected from beneath the surface of the sands to a position well above the influence of ordinary breakers. Backing the steps is a seawall of reinforced concrete with a front molded to a curve that will throw the breakers back upon themselves and thus counteract their destructive force. Every 150 ft. along the breakwater a concrete stairway will lead from the beach to the scenic boulevard, or esplanade, which will parallel the steps on the east. In front of the steps reinforced-concrete interlocking sheetpiles will be driven 15 ft. below mean tide, as a protection against the underscour of the seas, and as a foundation for the reinforced-concrete seawall, pedestral piles with mushroom bottoms will be driven at intervals of 10 ft.

Between the coping and the Great Highway, or esplanade proper, will be a promenade 25 ft. in width, of artificial stone. This will be built on a slight slope draining toward the parapet wall, through which will be scupper holes to release any water from wave crests which may top the parapet.

The price estimated for the construction of the first section, to be constructed along the beach for a distance of 650 ft. southward from a point near the terminus of Cabrillo St., is about $18,500. The design and construction are under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

Activated-Sludge Progress at Cleveland, Ohio

Plans for a 1,000,000-gal. unit of activated-sludge tanks have been completed for Cleveland, Ohio, under the direction of R. Winthrop Pratt, consulting engineer. The plans have been so drawn that this unit could, with moderate changes, be made a part of the Imhoff sewage-treatment scheme already tentatively adopted for the east-side disposal works at Cleveland. Bids for the work were to be received on Sept. 15.

The small experimental activated-sludge tank at Cleveland, described in the review of activated-sludge experiments in *Engineering News* for July 15, 1915, is giving good results. The effluent from this tank after three hours aëration and ten or fifteen minutes sedimentation is bright and clear; in fact, it compares very favorably in appearance with the city water-supply.

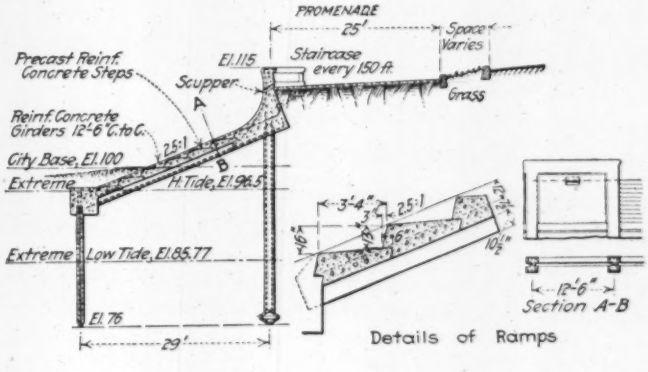


FIG. 1. DETAILS OF SEAWALL AT ESPLANADE

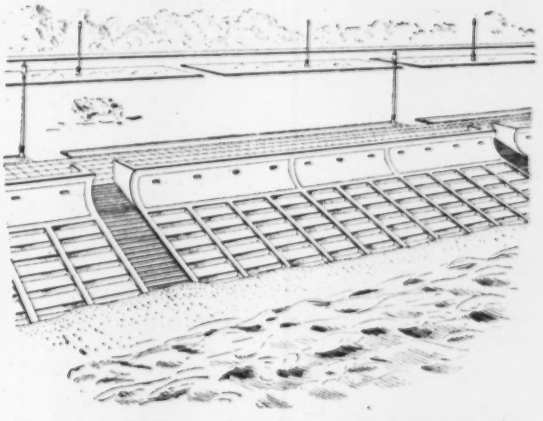


FIG. 2. PERSPECTIVE OF SHORE PROTECTION

Status of the Bronze Troubles on the Catskill Aqueduct

Rumors about new and greater troubles with cracking of bronze on the Catskill Aqueduct, New York City, are answered by Alfred D. Flinn, Deputy Chief Engineer, as follows:

Information on the subject up to about six months ago has already appeared.[1] For certain bolts, ladders, pipe fittings, valves and similar parts which would be exposed to moisture and difficult of replacement, the engineers of the Board of Water Supply sought a material highly resistant to corrosion and of sufficient strength to replace cast iron and steel, commonly used for such purposes. After careful inquiry, manganese bronze, Tobin bronze and naval brass were adopted. In the course of time some bolts were found cracked, and as time progressed this trouble with rolled and drawn material proved to be so extensive as to require replacement in a great many instances. The large forgings, principally for valve and sluice-gate stems, have developed no defects. Most of the castings have continued to be sound.

Recently, however, a number of castings, especially parts of large bronze gate valves, have developed fine cracks. Apparently these cracks result from repairs of foundry defects made by the process of "burning in," or welding, which has long been practiced in most if not all brass foundries. These valves are in chambers near the surface of the ground, where they are accessible for removal, for replacement or for such repairs as may be decided upon. The trouble mentioned is annoying, but will not delay the introduction of Catskill water beyond the time expected, the fall of 1916.

N. Y. Fire Department Reports on Subway Dangers

As a result of the serious fire in the New York subway on Jan. 6, 1915 (noted in *Engineering News*, Jan. 14, 1915), and at the request of the mayor, a study of the New York subway from the standpoint of the fire department was made by John Kenlon, Putnam A. Bates and Joseph O. Hammitt, all of the department. After an extended investigation they have recommended the following measures, as needed fire-prevention work: The substitution of steel cars for wood; isolation of buildings and show windows from the subway by fire walls; installation of electric wiring in fireproof conduits; use of slow-burning wood for third-rail guards; use of metal news-stands, doors, lockers, etc., in the stations; improvement of general house-keeping conditions in workshops and locker rooms; reduction and safeguarding of the storage and use of inflammable liquids; complete isolation of the various electric-wiring systems from one another to prevent communication of a breakdown; installation of emergency lights along the subway; duplication of current supply for lighting; installation of a complete fire-alarm system of approved construction, connecting with fire headquarters; installation of a complete additional telephone system connecting the power plant and executive offices of the operating company with stations every 500 ft. throughout the subway; reconstruction of splicing chambers to segregate wiring systems and to prevent escape of smoke or gases into the subway; better upkeep of emergency battery lamps in cars and equipment of each car with portable electric lamps; division of the subway by longitudinal walls between tracks, with protected openings at 500-ft. intervals; additional and improved emergency exits to the street; training of operating employees in regard to procedure in case of fire.

[1] See "Engineering News," Nov. 26, 1914, p. 1092, "Unsatisfactory Performance of Brass and Bronze on the Catskill Aqueduct," stating the nature and extent of the cracking; and July 8, 1915, p. 69, "Cracking of Copper Alloys," which discusses the vital relation of corrosion to the phenomenon.

City of Philadelphia Starts Rapid-Transit Work

Extension of Philadelphia's one subway line (Market St.) into a large municipal rapid-transit network began last week with the start of work on subway and elevated contracts awarded in August. Bids are also asked for another section of elevated, to be opened Oct. 19. Henry H. Quimby, Chief Engineer of the Department of City Transit,[1] gives the following statement:

The subway contract covers the City Hall Station section of the Broad St. line, extending from Filbert St. to South Penn Sq., about 750 ft. long, passing under the present subway line in Filbert St. and in South Penn Sq., and passing also under City Hall diagonally, with four tracks and two island platforms, and including galleries, entrance stairs, escalator wells, ventilation, drainage, etc.

The elevated contract covers the column foundations and piers for about 5 mi. of line from Front and Callowhill St. to Frankford Ave. and Unity St.

The work embraced in these contracts and in the ones that will follow shortly to complete the construction of the first five miles of the Frankford Elevated was authorized by ordinance of Councils July 2, 1915, to be paid for out of an initial loan of $6,000,000, approved for the purpose by the voters of the city at a special election held Apr. 29, 1915, and apportioned by Councils equally between the subway and the elevated.

The initial loan was limited to this amount because of the expectation of the adoption by the electors of the state at the November election of a constitutional amendment, which has already been passed by the Legislature and now requires only the approval of the voters, and which, if so approved, will not only extend the borrowing capacity of the city, but will permit the borrowing to be done upon longer-term bonds, and the funding of interest and sinking-fund charges during construction, and the grading of the sinking-fund payments so that in the early years of operation they will be light and in the later years of their term they will be heavier to make up the amortizing amount.

As soon as the municipal legislation authorizing the work was enacted, the construction plans were submitted to the Public Service Commission of Pennsylvania for approval and for a certificate of public convenience, which is by law required to be obtained from the commission before any new lines or extensions of lines are constructed. The certificate was granted and the plans approved Aug. 14. A taxpayer's suit was brought July 10, to restrain the department from proceeding with the work, but after the decision of the Public Service Commission the suit was

[1] 1754 Bourse Building, Philadelphia, Penn.

withdrawn. The contracts were then immediately awarded.

Bids are now being invited, to be opened Oct. 19, for the steel superstructure of the 5-mi. stretch of the Frankford Elevated, and contracts will follow for the concrete floor and for the station platforms, buildings and stairs.

Additional sections of subway will be advertised soon. The one now under way was made the first because it involves the most difficult and tedious work and will require the longest time to complete, there being about 3,000 ft. of heavy and thick walls to underpin besides the two lines of existing subway structure.

Additional sections of elevated will be advertised as soon as the south terminus of the line is determined, this portion of the route being dependent upon the outcome of negotiations for the operation of the lines. If a satisfactory contract shall be made with the trolley company, which also owns the Market St. rapid-transit line, the Frankford Elevated will be connected to the Market St. line at Front and Arch St. Construction plans for this route are complete, and it is expected that if there shall be no delay in the program the Frankford line can be completed for operation early in 1917.

Preliminary construction work on the subway system has been in progress since Mar. 20, 1915, when the relocation and reconstruction of sewers were commenced. Six contracts were placed for this advance work, involving about $450,000, and three of them have been completed.

The plans of the Department of City Transit, which was organized under authority of special state legislation to have supervision and control of the transit facilities of the city and is presided over by Director A. Merritt Taylor, contemplate the immediate construction of about 11 mi. of subway north and south in Broad St. (half four-track and half two-track), with elevated spurs to the east and the west at the north, together with a double-track elevated railway 7 mi. long to the Frankford district of the city, nearly paralleling the Delaware River, and probably making a connection with the present Market St. subway for operation through the central business district; estimated cost of structure $34,000,000.

The plans cover also a 6-mi. double-track elevated railway southwestward to the Darby district, to be built immediately after the completion of the Frankford line and to connect provisionally with the Market St. line at 30th St.; estimated cost of construction $4,500,000. Also, later, a double-track subway under the Parkway connecting with the Broad St. subway at City Hall, emerging in Fairmont Park and extending as an elevated along 29th St. and Henry Ave. to the Roxborough district, 8 mi. Also, as traffic will make necessary, a 1½-mi. delivery loop for the Broad St. subway in the central business district.

Studies and tentative plans have been made for a subway under Chestnut St. through the central business district and connecting the Frankford and Darby lines when traffic in the Market St. subway shall have reached the limit of the capacity of that line.

U. S. Naval Advisory Board

The personnel of the Naval Advisory Board of Inventions appointed by Josephus Daniels, Secretary of the Navy, has been already announced piecemeal in the personal columns of *Engineering News*. The complete board consists of 23 members; the chairman and original appointee is Thomas A. Edison. The other 22 members were chosen (in most cases by the governing boards) by the eleven principal engineering and scientific societies, and their formal appointment by Secretary Daniels has just been announced. These appointees are listed below according to the society they represent:

American Society of Civil Engineers—Andrew Murray Hunt, Consulting Engineer, of San Francisco, Calif., is a native of Sioux City, Iowa, and a graduate (1875) of the United States Naval Academy. His engineering activities include hydro-electric and irrigation developments, steam-power and gas plants, oil refineries, cement-manufacturing plants and other industrial works. Alfred Craven, Chief Engineer of the Public Service Commission, First District, New York, is a native of New Jersey and was graduated from the United States Naval Academy in 1867. A biographical sketch of Mr. Craven was published in *Engineering News* Oct. 8, 1914.

American Society of Mechanical Engineers—William Le Roy Emmet was born in New York State and is a graduate (1881) of the United States Naval Academy. He designed and directed the development of the Curtis steam turbine by the General Electric Co. and has done much in the field of electric power for ship propulsion, as well as other electrical engineering work. Spencer Miller was born in Illinois and was graduated from Worcester Polytechnic Institute in 1879. He is Chief Engineer of the Lidgerwood Manufacturing Co., New York City, and is noted for his cableway inventions, particularly the adaptation of this device to coaling ships at sea.

American Institute of Electrical Engineers—Frank Julian Sprague, a native of Connecticut and a graduate of the United States Naval Academy (1878), is the founder of the Sprague Electric Co. and an electrical engineer of international reputation. B. G. Lamme was born in Springfield, Ohio, and was graduated from Ohio State University in 1888. He has designed much electrical machinery and is now Chief Engineer of the Westinghouse Electric and Manufacturing Co.

American Institute of Mining Engineers—William Lawrence Sanders was graduated from Pennsylvania University in 1876. He is Chairman of the Board of Directors of the Ingersoll-Rand Co. and the inventor of many improvements to drilling machinery. Benjamin Bowditch Thayer was born in San Francisco and was graduated from Harvard University in 1885. He is a noted mining engineer and is President of the Anaconda Copper Mining Co.

The Inventors' Guild—Peter Cooper Hewitt, of New York, and Thomas Robins, President of the Robins Conveying Belt Co., Passaic, N. J.

American Society of Automobile Engineers—Andrew L. Riker, of Detroit, and Howard E. Coffin, Vice-President of the Hudson Motor Car Co., Detroit, who was educated at the University of Michigan.

American Society of Aeronautic Engineers—Henry A. W. Wood, New York City, and Elmer Ambrose Sperry, New York City, a graduate of Cornell University.

American Electro-Chemical Society—Joseph William Richards, South Bethlehem, Penn., a graduate of Lehigh University, and Lawrence Addicks, who was graduated from the Massachusetts Institute of Technology in 1889. Consulting Engineer of Phelps, Dodge & Co., New York City.

American Chemical Society—W. R. Whitney, Director of the Research Laboratory of the General Electric Co., Schenectady, N. Y., is a graduate of Massachusetts Institute of Technology (1890). L. H. Backeland is a Belgian and a graduate of the University of Ghent and is famous as the inventor of "Velox" photographic paper and of "Bakelite," an insulating material.

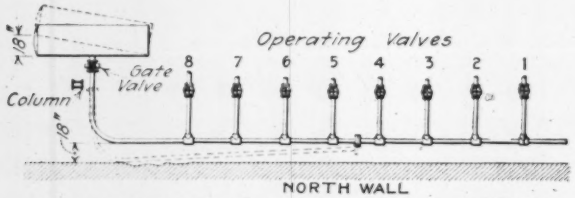
American Aeronautical Society—Matthew Bacon Sellers, Baltimore, Md., a graduate of Harvard University, and Hudson Maxim, of Brooklyn, N. Y.

American Mathematical Society—Robert Simpson Woodward, Washington, D. C., a graduate of Michigan University, President of the Carnegie Institution, and Arthur Gordon Webster, a Harvard graduate, Professor of Physics at Clark University, Worcester, Mass.

Hydraulic Elevators Shut Down by Broken Gate Valve*

Seven of the eight hydraulic elevators in the Bowling Green Building, New York City, sank to the bottom when a 14-in. gate valve in the main line from the high-pressure water-storage tanks to the elevator-machine cylinders broke, at noon on Sept. 3. The other elevator was at the bottom already and therefore did not participate in the accident.

The accompanying diagram indicates what took place when the valve casing broke. The high-pressure water was contained in two cylindrical tanks, one above the other



SUPPLY LINES FOR BOWLING GREEN ELEVATORS

and connected by a pipe. The lower tank was kept full, the upper nearly so except for the air at the top, under 180 lb. pressure. The storage water was of course released. The tanks were thrown out of place horizontally about 18 in., and the pipe line was thrown out in the opposite direction about the same distance, being stopped by the north wall of the building. The valve was further damaged by striking the column shown in the diagram.

When the valve broke, the operating valves in the elevator cars closed immediately, allowing the escape of only a gallon or two of water from each of the vertical cylinders in the shaft. All the cars descended at not more than normal speed until they were within a few inches of the bottom, when the effect of the slight leakage was felt and the cars dropped with a bump. None of the 30 passengers was injured.

About half the main pipe line was practically undamaged, as indicated in the diagram. The four elevators on this portion of the line were speedily put in operation, power being furnished by the low-pressure (120 lb.) supply.

Levee Flood Gates Were Carried Out in East St. Louis last week during a fall of the Mississippi River. These backwater gates (on Cahokia Creek) are reported to have been built for temporary use by the East Side Levee and Sanitary District in 1912, and this outlet would eventually have been abandoned. The old creek channel stood full and the gates were clogged.

*Noted in "Engineering News," Sept. 9.

The Retaining Walls for the Levee of the Kaw River Drainage District, Kansas City, Kan. (see "Engineering News," Aug. 26, 1915, p. 430), are to be redesigned before construction.

The Injunction in the Minneapolis Water-Filter-Patent Suit (Ira H. Jewell vs. City of Minneapolis; see "Engineering News," Sept. 9, 1915, p. 523) has been suspended until a decision is reached in an appeal to the United States Circuit Court of Appeals.

PERSONALS

Capt. Harold C. Fiske, Corps of Engineers, U. S. A., has been relieved from duty at Pittsburgh, Penn., and will be stationed at Vicksburg, Miss.

Maj. Elliott J. Dent, Assoc. M. Am. Soc. C. E., Corps of Engineers, U. S. A., has been relieved from duty in New York City and will be stationed at Little Rock, Ark.

Mr. James P. Nelson, a member of the Valuation Committee of the Chesapeake & Ohio Ry. Co., has been placed in charge of the engineering work of the committee.

Mr. Fred W. Cummings, Superintendent of the municipal garbage-reduction plant of Cleveland, Ohio, resigned on Aug. 31 to accept a position with a similar plant operated by a private company at Detroit, Mich.

Mr. E. S. Mudge, Division Engineer of the Atchison, Topeka & Santa Fé Ry. at Wellington, Kan., has been made Assistant Engineer in Charge of Valuation for the Western lines of the road, wtih headquarters at Amarillo, Texas.

Mr. W. P. Danford, formerly City Engineer of Durant, Okla., has been appointed Assistant State Engineer of the State Highway Department, with headquarters at Oklahoma City. He will act as State Engineer until Oct. 1.

Mr. P. J. Flynn, Manager of the Winnipeg Union Terminals, has been appointed Superintendent of the Canadian Northern Ry., with headquarters at Winnipeg, Man. He succeeds Mr. M. B. Murphy, who has been transferred to Calgary, Alta.

Mr. W. D. Pearce, Assistant Engineer of the Northern Pacific Ry., has been appointed Supervisor of Bridges and Buildings on the Yellowstone division, with headquarters at Glendive, Mont. He succeeds Mr. W. C. Sloan, who has been promoted.

Mr. Frank C. French, M. Am. Soc. C. E., who for several years past has been connected with the Butte & Superior Copper Co. and other copper properties in the Butte district, will reopen offices in Salt Lake City for the practice of civil and mining engineering.

Mr. R. D. Starbuck, Special Engineer on the staff of Mr. J. J. Bernet, Vice-President of the New York Central & Hudson River R.R., at Chicago, has been transferred as Special Engineer on the staff of Mr. A. T. Hardin, Assoc. M. Am. Soc. C. E., Vice-President in Charge of Operation, at New York City.

Mr. Julius Edgar Willoughby, M. Am. Soc. C. E., Assistant Chief Engineer of the Atlantic Coast Line, has been made Chief Engineer, with headquarters at Wilmington, N. C., to succeed the late E. B. Pleasants. Mr. Willoughby entered the service of the Atlantic Coast Line as Assistant Chief Engineer in 1913, which position he has held until his present appointment.

Mr. John G. D. Mack, M. Am. Soc. M. E., Professor of Machine Design in the College of Engineering, University of Wisconsin, has been appointed State Chief Engineer by the Railroad Commission of Wisconsin, with a salary of $6,000 a year. Professor Mack will have charge of and supervision over all engineering work for the state, including the engineering work of the Railroad, Highway and Tax Commissions. He has been a member of the University Faculty for nearly 25 years.

OBITUARY

William F. Endress, Captain, Corps of Engineers, U. S. A., died Sept. 7 from pneumonia while on board the steamer "Allianca" en route from Colon to New York.

John Haines Warder, Assoc. Am. Soc. C. E., whose death was noted in "Engineering News" of Sept. 9, became Secretary of the Western Society of Engineers in January, 1901,

which position he held until his death. He resigned as Assistant Engineer of the Bureau of Sewers of Chicago to accept the position of Secretary of the society.

Edward B. Moore, ex-United States Commissioner of Patents, died Sept. 7 at his home in Washington, D. C. Mr. Moore was born at North Anson, Me., in 1851. After receiving a high-school education he became a page in the United States Senate. In 1881 he was admitted to the bar and in 1883 became an assistant examiner in the Patent Office, with which he was connected for 30 years. He was Commissioner from 1907 to 1913, at which time he left the Patent Office to become a member of the law firm of Moore & Clark in Washington.

Dr. Karl E. Guthe, Dean of the Graduate Department, University of Michigan, died at Ashland, Ore., on Sept. 11. Dr. Guthe was born in Hanover, Germany, in 1866, and received his education in the Hanover Technical School and the Universities of Marburg, Strassburg and Berlin. He came to the United States in 1892 and entered the University of Michigan as an instructor in physics, being made Assistant Professor in 1900. In 1903 he was appointed Associate Physicist in the United States Bureau of Standards, and in 1905 was Professor of Physics in the Iowa State University. The same year he was made Professor of Physics at the University of Michigan. In 1909 he became Dean. Dr. Guthe was the author of several books on physics and a member of the Bureau of Awards of the St. Louis Exposition.

Sir William C. Van Horne, K. C. M. G., Assoc. Can. Soc. C. E., a noted railroad builder and financier of Canada, died at the Royal Victoria Hospital in Montreal, Sept. 11. Sir William was born in Will County, Ill., in 1843, and at the age of 13 was left upon his own resources. He worked in the railroad yards and afterward as a telegraph operator with the Illinois Central R.R., after rapid strides becoming General Superintendent of the St. Louis, Kansas City & Northern Ry. Later he was connected with the Southern Minnesota Ry. as General Manager and the Chicago & Alton R.R. and the Chicago, Milwaukee & St. Paul Ry. as General Superintendent. In 1882 he moved to Canada and became General Manager of the Canadian Pacific Ry. and superintended its extension to the Pacific Coast. Sir William was Vice-President of the road from 1884 to 1888, President from 1888 to 1899 and was made Chairman of the Board of Directors the following year. He was knighted by Queen Victoria in 1894 in recognition of his railway work in Canada and for his interest and services in public affairs.

Dr. John E. Sinclair, Professor Emeritus of Mathematics at the Worcester Polytechnic Institute, died Sept. 12 at his home in Worcester, Mass. He was born at Brentwood, N. H., Mar. 28, 1838, and was graduated from Dartmouth College in 1858. He began teaching at Adrian, Mich., the same year, and from 1859 to 1863 he was an instructor at Washington University, St. Louis, Mo., where the honorary degree of A.M. was conferred upon him in 1862. From 1863 to 1869 he was Assistant Professor and Professor of Mathematics at Dartmouth. He was made Professor of Mathematics at Worcester Polytechnic Institute at the inception of the school in 1869 and was head of the mathematics department until 1908. Practically every graduate of the Institute up to that year passed through his hands in "calc. and analyt.," and no professor was ever more original in his methods of instruction or more dearly loved than "Johnny Sin²," as he was affectionately called by generations of Worcester men. Dr. Sinclair was retired on a well-earned pension in 1907. At the recent semi-centennial anniversary of the Institute he was an honored guest.

ENGINEERING SOCIETIES

COMING MEETINGS

NORTHWESTERN ROAD CONGRESS
Oct. 4-7. At Cedar Rapids, Iowa. Secy., Jas. P. Keenan, Milwaukee, Wis.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION.
Oct. 11-12. Secy., Will P. Blair, Engineers Bldg., Cleveland, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 12-14. Annual convention at Dayton, Ohio. Secy., Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

SAN FRANCISCO MEETINGS

INTERNATIONAL ENGINEERING CONGRESS.
Sept. 20-25. W. A. Cattell, Secy., Comm. of Management, Foxcroft Bldg., San Francisco.

INTERNATIONAL IRRIGATION CONGRESS.
Sept. 20. Secy., Arthur Hooker, Sacramento, Calif.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Sept. 20. Secy., F. F. Sharpless, 52 Broadway, New York City.

PACIFIC COAST ASSOCIATION OF PORT AUTHORITIES.
Sept. 20 and 21. Secy., Leo V. Merle, Ferry Bldg., San Francisco, Calif.

AMERICAN MINING CONGRESS.
Sept. 20-22. Secy., J. F. Callbreath, Washington, D. C.

INTERNATIONAL ASSOCIATION OF BRIDGE AND STRUCTURAL IRON WORKERS.
Sept. 20-30. Secy., Harry Jones, American Central Life Bldg., Indianapolis, Ind.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Sept. 21 and 22. Secy., F. M. White, Madison, Wis.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Sept. 23 and 24. Secy., W. H. Ross, 154 Nassau St., New York City.

AMERICAN MINE SAFETY ASSOCIATION.
Sept. 23 and 24. Secy., H. M. Wilson, Bureau of Mines, Pittsburgh, Penn.

AMERICAN ASSOCIATION OF REFRIGERATION.
Sept. 23 and 24. Secy., J. F. Nickerson, 431 South Dearborn St., Chicago, Ill.

ILLINOIS GAS ASSOCIATION.
Sept. 27. Adjourned meeting. Secy., H. H. Clark, 72 West Adams St., Chicago, Ill.

SAFETY CONFERENCE.
Sept. 27-30. A. C. Carruthers, Vice-Pres., Collective Insurance & Universal Safety Exhibit, Mines and Metallurgy Bldg., San Francisco.

INTERNATIONAL GAS CONGRESS.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN GAS INSTITUTE.
Sept. 27 to Oct. 1. Secy., George C. Ramsdell, 29 West 39th St., New York City.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN ELECTRIC RAILWAY MANUFACTURERS' ASSOCIATION.
Oct. 4-9. Secy., H. G. McConnaughy, 165 Broadway, New York City.

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.
Oct. 4-9. Secy., E. B. Burritt, 8 West 40th St., New York City.

Pan-American Road Congress—The Pan-American Road Congress is scheduled to be held all next week in Oakland, under the joint auspices of the American Road Builders' Association and the American Highway Association. Other road associations holding their conventions on the same dates are the Tri-State Good Roads Association and the Pacific Highway Association.

Engineers' Society of Pennsylvania—On Sept. 17-18, members of the society intend to make an inspection trip to Torresdale, where a filtration plant and experimental sewage-disposal plant are situated. The party will then go by special boat down the Delaware River, viewing the harbor improvements and visiting League Island Navy Yard and the New York Shipbuilding plant. Theater parties are planned for the evening of the 17th. The next morning the party will go by automobile to the Baldwin Locomotive Works and in the afternoon to a ball game. The Secretary is E. R. Dasher, 31 South Front St., Harrisburg, Penn.

American Society for Municipal Improvement—The 22nd annual convention will be held in Dayton, Ohio, Oct. 12-15, at the Hotel Miami. Proof sheets of the program have just been received in this office, indicating that the program of the convention will soon be issued to the membership. A banquet will be tendered by the National Paving Brick Manufacturers' Association on Oct. 12. The entertainment of the ladies is in charge of the Dayton Engineers' Club, and the program for the week has been arranged. The secretary of the Municipal Improvement Society is Charles Carroll Brown, 702 Wulsin Bldg., Indianapolis, Ind.

"The Smoke Prevention Association"—At the tenth annual convention of the International Association for the Prevention of Smoke, held in Cincinnati, Sept. 8 to 10, the name of the society was changed to the Smoke Prevention Association. The 1916 convention will be held in St. Louis. Prof. J. J. O'Connor, of the Mellon Institute of Industrial Research, University of Pittsburgh, stated that Pittsburgh intends to hold a large exhibition of smoke-prevention appliances in 1917 and wants the convention there that year. Officers were elected as follows: President, William A. Hoffman, St. Louis; Vice-President, Charles W. Heath, Cincinnati; Secretary-Treasurer, Frank Chambers, Chicago.

American Public Health Association—The annual convention held at Rochester, N. Y., Sept. 7-10, was one of the largest and most successful in the history of the association. Many papers were presented before the association as a whole and before the half-dozen sections. Dr. John F. Anderson, Di-

rector Hygienic Laboratory, United States Public Health Service, was elected President, to succeed Prof. William T. Sedgwick, of the Massachusetts Institute of Technology, and Prof. Selskar M. Gunn, 755 Boylston St., Boston, Mass., was reëlected as Secretary. Prof. George C. Whipple, of Harvard University, was elected Chairman, and Theodore Horton, Chief Engineer of the New York State Department of Health, was made Vice-Chairman of the Sanitary Engineering Section. The 1916 convention will be held at Cincinnati.

Appliances and Materials

Contractor's Measuring Wheelbarrow

The barrow shown in the accompanying illustration has been developed by the Sterling Wheelbarrow Co., of West Allis, Wis., in response to the demands of contractors laying concrete sidewalks, bases for asphalt and wood-block pavements, etc. The demands of most municipalities where such

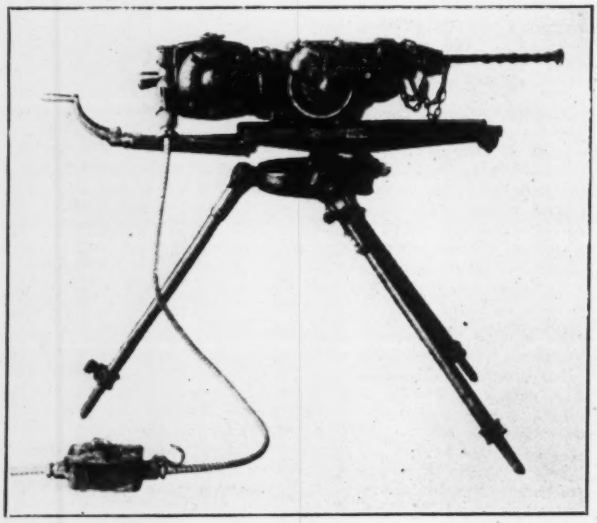
CONTRACTOR'S MEASURING BARROW

work is being done are for careful measuring of ingredients and material placed, and on the majority of these jobs a barrow of known capacity is the most convenient measure. This wheelbarrow is regularly furnished in 2- and 3-cu.ft. sizes.

• • •

Electric Percussion Rock Drills

After making trial installations of an electric rock drill for several years, the Fort Wayne (Ind.) Electric Works have standardized their line for regular production The drill, as shown in the accompanying views, is of a rotary-hammer type



SIDE AND PHANTOM VIEWS OF FORT WAYNE ELECTRIC PERCUSSION ROCK DRILL

for mounting on tripod, column or bar. A rotating helve carries two hammers and is belt-driven (850 r.p.m.) by the driving motor, using a tightening idler pulley to give speed variation. A round-headed hammer strikes a round-headed cap or tappet block against which the drill steel is set. On the recoil the hammers are cushioned by the air trapped in the hammer chambers. Normally, the drill gets 1700 blows per min. Around the steel is also a sleeve gripping it and itself rotated by a worm gear on the helve shaft. Spring-steel plates hold the drill steel in the chuck and absorb the energy of the blows when the steel is not in rock. Special drills are used with a helical rib, or wing, going around from point to grip and serving to convey the rock punchings out of the drill hole. The motor has ball bearings; the other rotating parts are mounted in roller-bearings. All are packed in grease and require attention only about once in 30 days. The motors are fully inclosed and designed for use in wet places; they are furnished for 115, 230 and 550 volts, direct current, and 110 and 220 volts, single- or two-phase alternating current. From 1.5 to 2.5 hp. generator capacity is needed per drill.

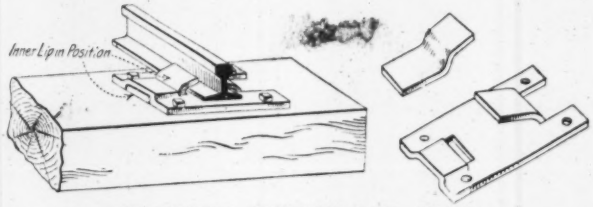
The machines now put out (A 10) are medium-capacity drills making holes up to about 12 ft. deep and finishing at 1½-in. bottom diameter. The body and shell weigh 275 lb., the motor 130 to 175 lb., the tripod 175 lb. This drill has a capacity equal to a 2½- or 3-in. piston drill which may require 12 to 18 hp. in compressors.

Electric drills are finding increasing use owing to their greater convenience and the saved investment in compressor, engine or motor, and piping—besides showing decreased maintenance and operating labor. Among the notable uses of these drills should be mentioned the Sun River irrigation project of the United States Reclamation Service (all machinery here driven by electricity as noted in "Engineering News," Oct. 29, 1914), and the Canadian Northern tunnel, near Duluth, Minn. The Rochester (N. Y.) Railway and Light Co. during the past three years has purchased several electric rock drills, which are rented to contractors doing work near the power lines.

• • •

Improved Two-Piece Rail Chair

An improved design of two-piece rail chair, to be used with driven or screwed spikes or bolt fasteners, is shown in



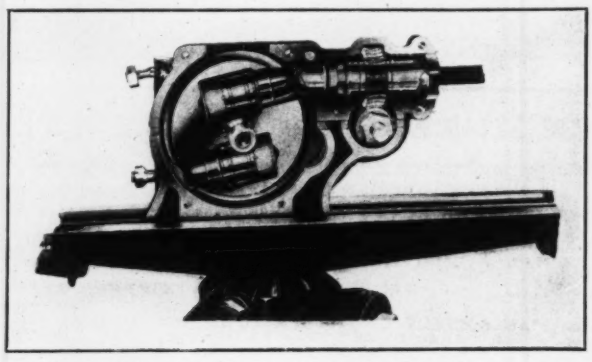
TWO-PIECE GRIPPING RAIL CHAIR

the accompanying sketch. The inner lip gives a strong grip on the rail base. The device is made by the American Rail Chair Co., Ewing Building, Findlay, Ohio.

• • •

One-Bag Low-Level Concrete Mixer

A new mixer (Rex No. 10) has been added to the line of the Chain Belt Co., of Milwaukee, Wis. This has a capacity of 10 cu.ft. and is assembled on a low truck for ease in charging, the platform (when used in place of a charging hopper) being 22 in. above the ground. The construction is all of steel and iron. The drum is cast in two sections and



bolted together. A sprocket for chain drive is bolted on sections around the middle of the drum. The frame is of steel channels and has 6x28-in. wheels. Steam engine and boiler, gasoline engine or electric motor can be furnished. The price is $450 without power loader and automatic tank.

Engineering News

VOLUME 74 SEPTEMBER 23, 1915 NUMBER 13

San Diego's Municipal Stadium

By F. A. Rhodes*

During the past spring there was completed in the city of San Diego, Calif., a large stadium, the cost of which was defrayed by the city. The structure will comfortably seat 28,000 people. The field has a ¼-mi. cinder track next the railing, inside of which are the football gridiron and the baseball diamond. The athletic building is divided into four compartments (for men, boys, women and girls), each with dressing room, lockers and showers. The building incloses a patio large enough for a handball or basketball court. The location of the stadium in proximity to the high school makes it a valuable adjunct to that institution.

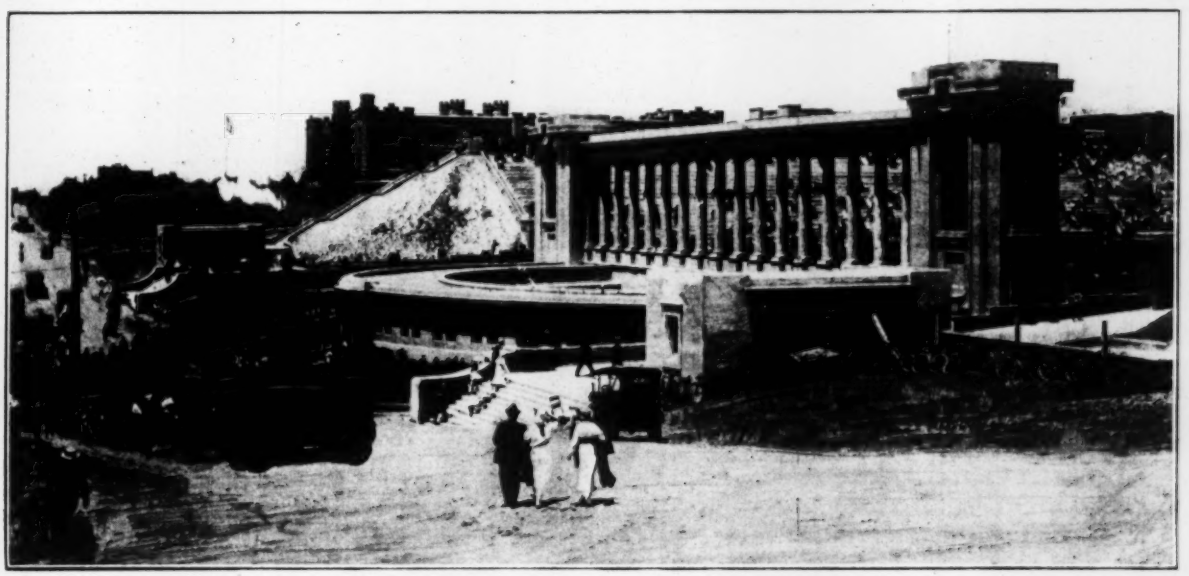


FIG. 1. ENTRANCE TO MUNICIPAL STADIUM AT SAN DIEGO, CALIF.

The sum of $150,000 was voted by the people of San Diego to provide a stadium for Balboa Park. Elaborate plans for a combination stadium and Greek theater were prepared by Quayle Bros. & Cressey, architects, the understanding with the stadium committee being that should their plans exceed the bond issue the difference would be raised by private subscription. When the bids were opened before the Board of Park Commissioners, it was found that the lowest was $325,000. The park board refused to award the contract unless the committee raised $175,000. Meanwhile the board called in the writer and requested that some method be worked out to save $30,000 or $40,000 in the grading of the site.

The site of the work was the southern end of the park where Fifteenth St. ended at the south park line. Fifteenth St. was a graded and improved street in a built-up district, but it was so graded that at A St. (the first street south and parallel with the park line) the drainage from all directions went to this intersection. The proposition to raise the grades of Fifteenth St. from B St. to the park line and of A St. on each side of Fifteenth as far as necessary and to fill in the adjoining property, raise the houses, etc., was put before the property owners. This change of grade was to provide a short haul for waste excavation from the stadium and give a continuous surface drainage from the stadium south on Fifteenth St. The property owners accepted $3000 to cover the cost of replacing sidewalks and curbs and raising their houses, which they preferred to do individually, the park board to furnish the dirt to fill the streets and property to the new elevations. The property owners lost about $4000 by not accepting the board's offer to do this work for them.

As a short haul on the excavation was the solution of the money-saving problem, so far as the earthwork was concerned, it was necessary to make the excavation and embankment quantities balance. This was done by building up the embankments on each side of the field to carry the concrete seats. The slopes on the inside were finished 30 to 17 and on the outside 2 to 1. The cut was trimmed 30 to 17 and in the north end was conical. The grading specifications provided that these fills be in 6-in. layers thoroughly wet and tamped. The dirt was dumped from the wagons, spread by a mormon scraper, rolled with a

*Consulting Engineer, 513 Union Building, San Diego, Calif.

petrolithic roller, thoroughly wet and then rolled again. The contours of the site are shown in light lines in the plan in Fig. 2. The excavation consisted of about 18 in. of topsoil, below which was a layer of hardpan about 18 in. thick. Below the hardpan a soft sandstone was encountered. In this sandstone were pockets of white sand and at a depth of 40 ft. was a layer of sea shells cemented in sand. The sandstone required loosening for the 60-ton 1½-yd. shovel, but by the time it had received the final rolling it had all dissolved to sand, containing just enough clay to bind it.

Two tests were made before the commencement of the work to determine if possible the percentage of volume of fill over cut. The first test was made by carefully cutting out a cubic yard in place and putting it in a yard box and thoroughly tamping it dry as the box was filled up. The fill swelled 20 per cent. over the cut. In the next sample, water was used in tamping, and the fill swelled but 10 per cent. over the cut. It was not thought advisable, however, to depend on the 10 per cent. swell of the fill and possibly be short of material on the wind-up. The estimated quantities adopted were 119,842 cu.yd. excavation and 118,175 cu.yd. embankment, an excess excavation of 1,667 cu.yd. The final quantities worked out remarkably close to this estimate. It was arranged to take care of any further excess or a shortage by raising or lowering the elevation of the stadium field without affecting any of the other work.

In finishing no changes were made in the field elevation, which was at El. 125 (Fig. 2), as the contractor disposed of the excess material. The test for swellage showed about 60 per cent. hardpan and 40 per cent. sandstone, whereas the total yardage contained about 95 per cent. sandstone and 5 per cent. hardpan. The sandstone dissolved to a sand containing a slight amount of clay and resumed the same volume in embankment as in place.

The topsoil was first stripped from the entire site and put into three piles, two at the upper end and one in the center of the field, at approximately the finished grade elevation. This top soil was afterward spread over the field and the outer exposed surfaces that are to be covered with verdure.

The bulk of the dirt was handled by one 1½-yd. railroad shovel and one ⅝-yd. revolving shovel, delivering into 2-yd. wagons. The average haul was about 500 ft. and the work was so arranged that all except about 30,000 yd. was on a downhill haul. When the west fill reached the point where the grade was too steep for the teams to pull up the loads, a cable was installed that enabled the

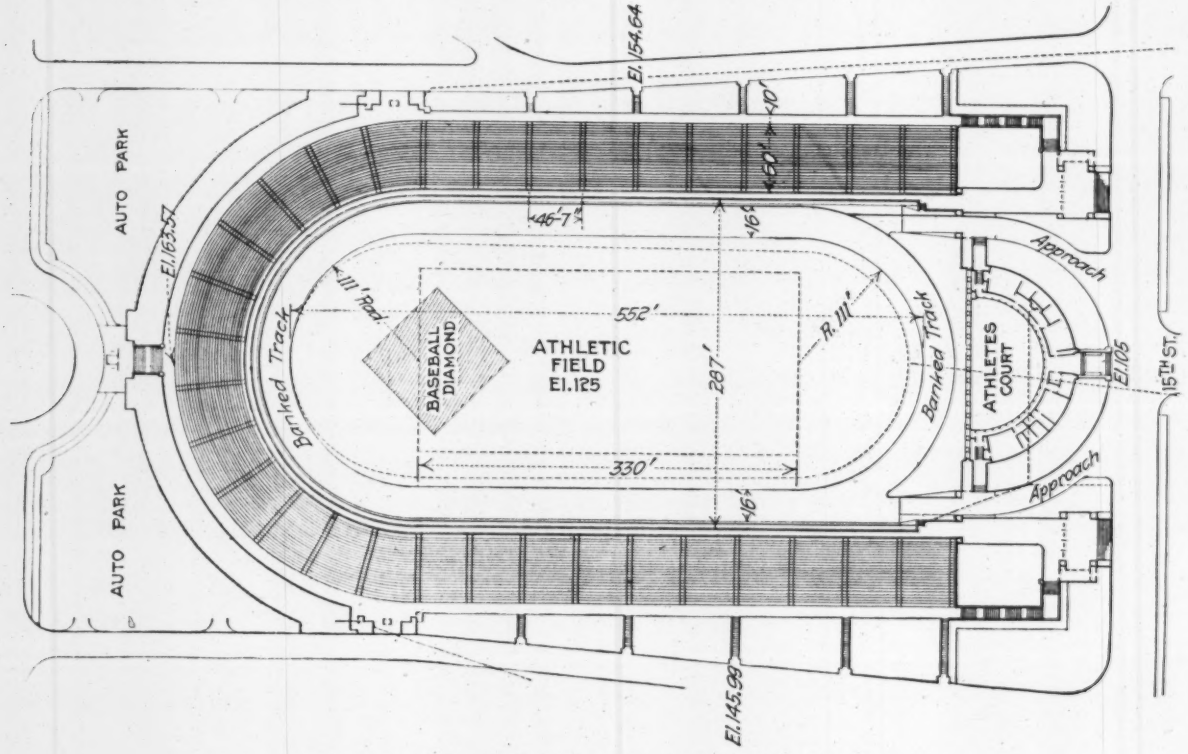


FIG. 2. PLAN OF THE SAN DIEGO MUNICIPAL STADIUM

empties returning to the shovel to assist the loaded teams to the top of the embankment. The slopes were trimmed to grade with a fresno scraper attached to the center of a cable, which passed through a block at both the toe and the heel of the slope. A team was hooked to each end of the cable and the scraper hauled up empty and loaded on downward trips. A portion of the slopes was also plowed in this manner.

The general layout of the stadium with its structures is shown in Fig. 4. The original design was revised to the extent of eliminating the Greek theater and the reinforced-concrete seats, but otherwise was not changed. The structures comprise a horseshoe-shaped series of seats—25 steps in all—made of concrete laid directly on the ground, step approaches at intervals along the outside slope, a rear entrance, a side entrance with toilet rooms attached and an elaborate front entrance of reinforced concrete (see Fig. 1) containing locker rooms, etc., and an imposing colonnade.

FIG. 3. EXCAVATING WORK IN PROGRESS ON THE SAN DIEGO MUNICIPAL STADIUM

The seats were cut out of the slopes (Fig. 6), commencing at the toe, and the concrete run six steps at a pouring. This method required one form for the face of the riser. The vertical joints were made by inserting sheet-iron strips dipped in oil in the wet concrete and pulling them when the concrete had set (Fig. 4). The horizontal joints were made by placing a strip of tarred paper on top of the riser, which was left in the concrete. The joints were put in to provide for a possible settlement in the embankment, to prevent bridging and irregular cracks and to facilitate any possible repair work. Each block can be removed and repoured if damaged. Some of the seats and risers have been in place eleven months; but they show no distortion nor cracks, other than the paper or cut joints.

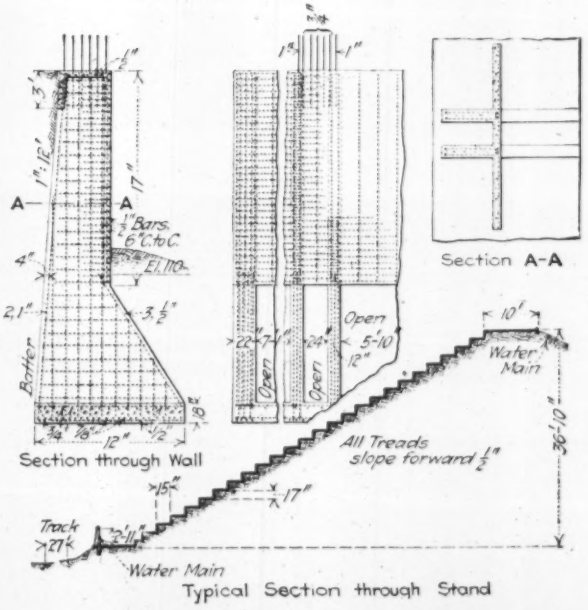


FIG. 4. DETAILS OF STEPS AND OF RETAINING WALL UNDER ENTRANCE COLONNADE

The concrete walk at the top of the steps drains to the seats; each row of seats has a ½-in. fall toward the field and drains to the lower concrete walk. This lower walk carries the water south, out over the two main entrance steps, where it empties into storm drains. The top walk and all the seats are laid on the same rate of grade as the lower walk. All drain to the south end of the stadium as well as toward the lower walk.

The field drains to a catch basin in the south end, and water is led out under the wall and athletic building to the main storm drain, which catches the storm waters from all the stadium roads.

The railing around the field carries a 2-in. water-main equipped with hydrants for washing down the seats. There is also a water line outside the top walk for the same purpose.

Retaining Wall Under Colonnade

The concrete wall at the south end of the field was designed to carry 16 columns, 25 ft. high, supporting a continuous cornice 8 ft. high and at the same time to retain a 16-ft. fill on its north side; the south side is used for playing handball. Fig. 4 shows the design and Fig. 5 the early part of this construction. The wall was made in one

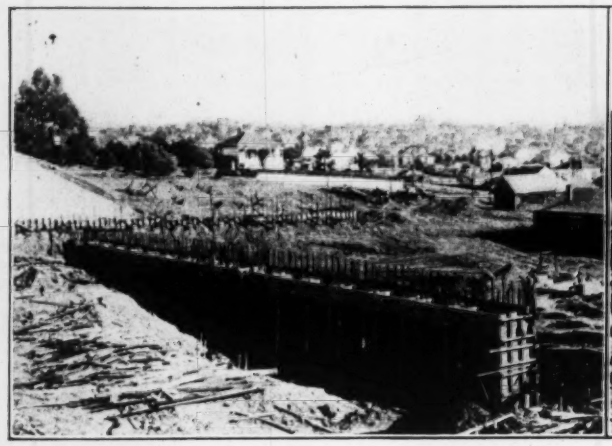


FIG. 5. RETAINING WALL UNDER CONSTRUCTION

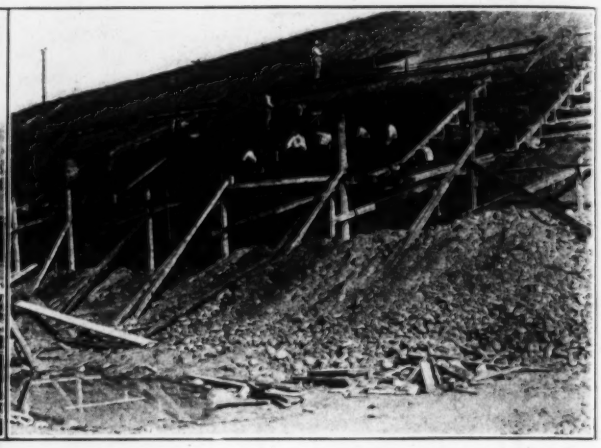


FIG. 6. LAYING STEPS FOR SAN DIEGO STADIUM

continuous pouring and has no joints. The face of the wall extends down from the top 17.25 ft., being 1 ft. below the finished grades on the south side of the wall, the foundation for the buttresses going from 1 to 12 ft. deeper.

The concrete mix used was one part cement, two parts washed river sand and four parts river gravel, crushed to ¾-in. size and washed. When the forms were stripped the wall presented smooth surfaces without pockets. This same mix was specified for the concrete seats and risers.

Bids were called for on the entire work, but in two parts—(1) grading and (2) general construction—with the provision that the park board reserved the right to do the grading work itself or let the contracts separately. The contract was let in two parts for $11,050 less than the lowest bid for the entire job. The basis for the earthwork bids was 110,000 cu.yd. excavation and 7,000 cu.yd. topsoil, and the two lowest bids were as follows:

F. O. Engstrum Co.:	
110,000 cu.yd. excavation at 35c	$38,500
7,000 cu.yd. topsoil at 35c	2,450
All other work	72,694
Total bid	$113,644
C. L. Hyde Construction Co.:	
110,000 cu.yd. excavation at 24c	$26,400
7,000 cu.yd. topsoil at 50c	3,500
All other work	93,000
Total bid	$122,900
Contracts as let:	
To C. L. Hyde Construction Co., for grading	$29,900
To F. O. Engstrum Co., all other work	72,694
Total contract	$102,594

The actual amount paid the contractors was $9,044.68 more than these figures, because of excess yardage over the basis of the bid, force account work, and extras on general construction.

In addition the cost of engineering, superintendence, architects, damages, inspection, advertising, blueprints, stationery, photographs, hardware, water meter, planting and other improvements was not covered by the contracts.

Quayle Bros. & Cressey did all the architectural designing and to them should be given the credit for all the utility, conveniences and beauty of the entire structure. H. S. Ervay and the writer worked out all the engineering problems, including the grades, seats, retaining wall, drainage and estimated costs. It was necessary, of course, to work in conjunction with the architects to keep the costs within the appropriation. The estimate of cost was $140,000. The park commissioners retained the writer as Engineer and Superintendent of Construction until the completion of the work. It was dedicated to the public, May 31, 1915, at which time about 20,000 people were seated in it.

⁂

The Average Discharge of the Tennessee River at points in North Carolina and Virginia where the river joins the Ohio has been investigated by the United States Geological Survey during the past year, and the findings were recently reported. The average flow of the river at its mouth is 63,000 cu.ft. per sec. This figure was determined by averaging the figures of a 39-yr. period (1875 to 1913). The report gives the daily flow at Chattanooga since 1874; at Florence, Ala., since 1895, and at Johnsonville, Tenn., since 1890. The average discharge at Chattanooga is 33,400 sec.-ft.; at Florence, 38,400; at Johnsonville, 42,000. The Geological Survey has also reported on the areas drained by important rivers in the neighborhood of the Tennessee. The Cumberland River drains an area of 17,900 sq.mi.; the Tennessee, 40,700; the Kanawha, 12,200; the Miami, 5410; the Wabash, 32,900, and the Allegheny, 11,700.

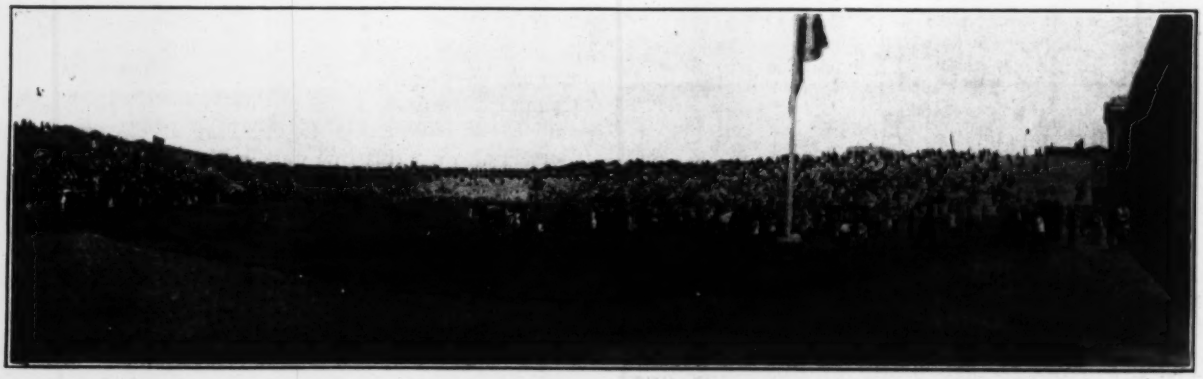


FIG. 7. THE COMPLETED SAN DIEGO MUNICIPAL STADIUM WITH ITS OPENING-DAY CROWD

Drainage Pumping Plant with Variable-Speed Drive

The Hartwell Drainage and Levee District has an area of about 10,000 acres in the northwestern part of Greene County, Illinois. The elevation of the bottom land varies from 426 ft. to 440 ft. (Memphis datum) and that of the river varies from 423 ft. to 440.5 ft. Under these conditions it was necessary to levee the district, and as the river is at flood stage during the crop season it is necessary to pump the run-off at these times.

Rainfall and Run-Off in Levee District

The levee extends along three sides of the district, and has a total length of 13 mi. It is 4 ft. above the highest known water, and has a slope of 1 on 3 for the river side and 1 on 2 for the land side, with a crown of 6 ft. Its only break is at the gravity outlet at the southwest corner of the district. This is a concrete structure with wing walls to hold back the fill and three 42-in. riveted steel pipes provided with hand-operated sluice gates. The elevation of the bottom of these pipes is 421.3 ft. and the top of the concrete wall is level with the levee top.

The rainfall in this section averages about 35 in. per year. The run-off is about 31%, but as there is considerable seepage from the river, 36% was used in estimating the pumpage. The pumping plant was designed to remove ¼ in. of rainfall from the entire watershed in 24 hr.

The run-off is conveyed by open ditches and tile drains. The main ditch leading direct to the pumping plant and gravity outlet is 11,284 ft. long. It has a bottom width of from 35 to 22 ft. and a depth of from 13 to 8 ft. Lateral No. 1, which empties into the main ditch, is 16,632 ft. long and from 12 to 24 ft. wide on the bottom, with an almost constant depth of 9 ft. Lateral No. 2, a continuation of the main ditch, is 13,130 ft. long, from 22 to 18 ft. bottom width, and averages 8 ft. deep. Lateral No. 3, another branch of the main ditch, is 11,150 ft. long, with other dimensions similar to No. 2. The bank slope of all the ditches is 1 on 1, and the fall varies from 0.5 to 1.2 per mile. The main ditch proper terminates at the suction bay, a branch leading off to the gravity outlet about 300 ft. south of the pumping station.

A general cross-section of the pumping station is shown in Fig. 1. The suction bay is built of 1:3:5 concrete, reinforced in both the floor and walls with triangular-mesh expanded metal. The floor is 12 in. thick, and the back and end walls are 4.5 ft. at the base.

The trash-rack (which has not yet been built owing to the immediate need of pumping) will extend across the main ditch 75 ft. east of the suction bay. It will consist of a concrete foundation and cutoff wall and concrete piers carrying steel I-beams to hold the tops of steel bars, $\frac{5}{16}$x1¾ in., spaced 2 in. c. to c. The lower ends of these will rest on the concrete foundation.

The back wall of the suction bay forms part of the building foundation. The remainder of the foundation is 1:2:5 concrete. The 6-in. floor of the building is of 1:2½:5 concrete, reinforced with woven wire netting. Level with the top of the floor and extending 7 ft. below it are the foundations for the pumps and motors. The building is 65x30 ft. in plan with brick walls and a slate roof. A 5-ton traveling crane runs on 10-in. I-beams carried by pilasters along the west wall and 12-in. I-beams on steel columns along the center of the building.

The three pumps, made by the Alberger Pump & Condenser Co., are of the double-suction, centrifugal, horizontal-shaft, volute type, with 30-in. discharge. These are shown in Fig. 2. The impellers are of bronze. The 24-in. suction pipes are of ¼-in. steel plates. They extend through the floor and back wall of the suction bay, and have bell ends 12 in. from the floor of the bay. The 30-in. discharge pipes are of similar construction. They extend through the west wall of the building (Fig. 3) and converge on curves of 21 ft. from 20 ft. to 5 ft. c. to c. at the top of the levee, and then run parallel with each other down the levee and through the back wall of the discharge bay. The ends are provided with flap valves (Fig. 1).

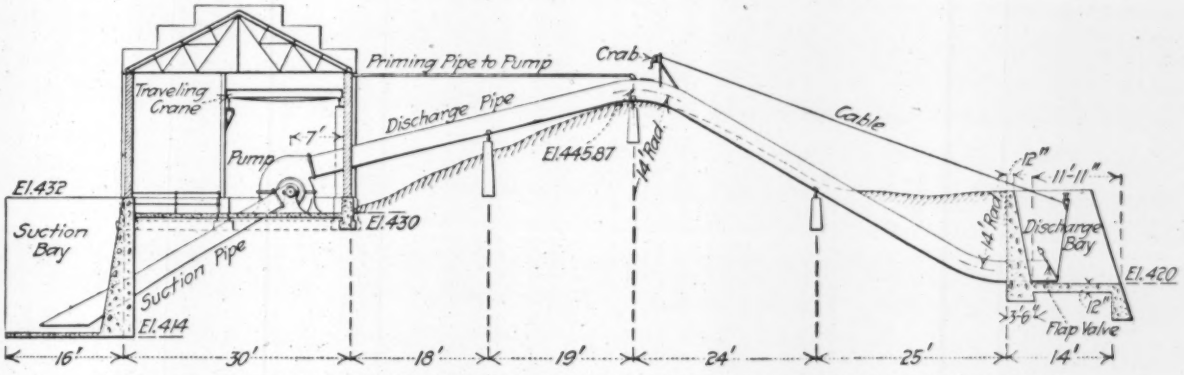


FIG. 1. CROSS-SECTION OF PUMPING PLANT FOR DRAINING THE HARTWELL LEVEE DRAINAGE DISTRICT, ILLINOIS

The pumps have 2-in. drain pipes running from the bottom of the volute under the floor to a common valve box built in the floor, and are drained into the suction bay. The pumps are guaranteed for a capacity of 22,500 gal. per min., an efficiency of 75% at 21-ft. total dynamic head and 300 r.p.m.; 68% at 12 ft. head, 251 r.p.m., and 58% at 8 ft. head, 251 r.p.m.

Pump Drive and Speed-Change Device

Each pump is driven by a 150-hp. 12-pole motor of the slip-ring type for 2,200-volt three-phase 60-cycle alternating current. They run at 600 r.p.m. with no load. They are guaranteed to withstand a voltage of 5,000 volts for one minute and to have a full-load efficiency of 90%, with an 89% power factor. They are connected to the pumps by 44-in. Morse silent chains of 2-in. pitch, which are guaranteed to give an efficiency of

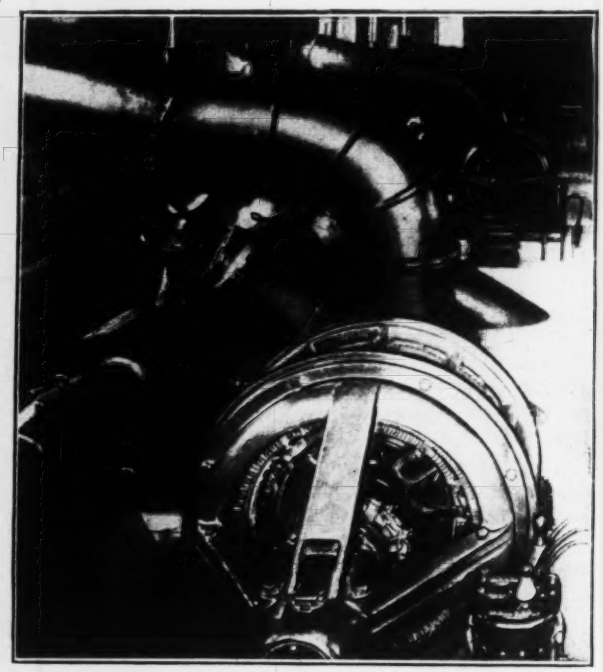


FIG. 2. DRAINAGE PUMPING PLANT WITH CHAIN DRIVE FROM ELECTRIC MOTORS TO CENTRIFUGAL PUMPS

98%. Each motor is equipped with pulleys of three sizes to give the pumps the speed required at the various heads. Power is supplied by the Northwestern Power Co., of Keokuk, Iowa, and is transmitted to Hull, Ill., at 110,000 volts, two-phase. There it is transformed and goes through a frequency changer and is transmitted from there at 33,000 volts, three-phase. The total distance of transmission is about 120 mi. The substation is in the northeast corner of the pumping station.

The pipes for priming the pumps are taken from the discharge pipes on top of the levee, 3-in. air lines being brought into the building overhead and through a safety tank 10 ft. long and 36 in. diameter to a compressor run by a 10-hp. motor. The purpose of the tank is to catch the entrained water. The pipe from the vacuum pump is taken out at the top of the tank. This method has proved superior to the barometric column method.

This is said to be the largest drainage pumping plant on the Illinois River, and probably the largest electrically operated drainage pumping plant in the country.

Method of Varying Pump Speed

The speed of the pumps is varied to suit the conditions of water level by changing the chain sprocket on the motor shaft. Three pulleys are employed, with diameters of 8.11, 9.06 and 11.27 in., made with a slip fit on the shaft. The apparatus used in making the change is shown in Fig. 4. The sag of the chain is taken out by placing a pair of rigid frames beneath it. The frame for the upper run of the chain is bolted to it at one end, and its other end is raised by the hoisting chain of the traveling crane. The frame of the lower run of the chain is raised by a jack.

The motor is then shifted inward by means of its take-up screws until the pulley is clear of the lugs on the chain. A screwjack device placed on the end of the shaft and hooked over the pulley is used to pull off the latter. The new pulley is lowered into place by a sling from the traveling crane, and another jacking device, which is hooked to the arms of the motor frame, is then used to pull this pulley upon the shaft. The one man in charge of the plant can change the pulleys on all three motors and have the pumps running again in 30 min.

The largest pulleys will seldom be used, probably once in three or four years. The smallest and intermediate pulleys will be interchanged probably three or four times a year. The pumps (with small pulleys in place) were started March 20, and ran for 60 days before it was necessary to apply the intermediate pulleys on account of high water. These remained in use during the exceed-

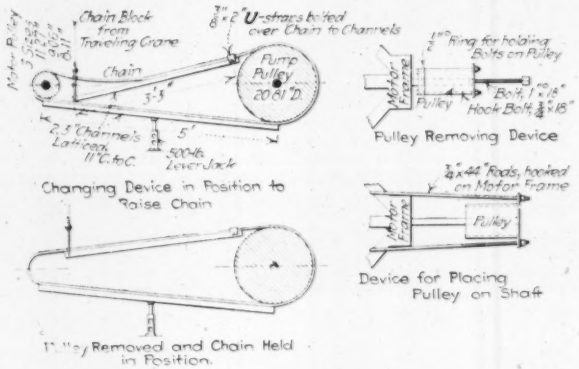

Chain Block from Traveling Crane
Chain
Pump Pulley 20.61" D.
3/8" x 2" U-straps bolted over Chain to Channels
1" Ring for holding Bolts on Pulley
Motor Frame
Pulley
Bolt, 1" to 1 1/8" Hook Bolt, 3/4" to 1"
Pulley Removing Device
2-5" Channels Lattices 11" C. to C.
5004b. Lever Jack
Changing Device in Position to Raise Chain
3/4" x 44" Rods, hooked on Motor Frame
Motor Frame
Pulley
Device for Placing Pulley on Shaft
Pulley Removed and Chain Held in Position.

FIG. 4. APPARATUS USED IN CHANGING THE CHAIN SPROCKET PULLEYS ON THE MOTOR SHAFT TO VARY THE SPEED OF THE PUMPS

ingly rainy period and consequent high-water stage of the river. At the beginning of the dry season in the fall the small pulleys will be replaced and will probably continue in service until next spring.

The tests so far made have been insufficient to determine exactly the friction head. The present instructions

FIG. 3. DISCHARGE PIPES OF DRAINAGE STATION AND OVERHEAD LINES FOR PRIMING PUMPS

to the operator are to use the small pulleys for heads of from 0 to 4 ft., the intermediates for from 4 to 10½ ft., and the large pulleys for heads above 10½ ft. These are static heads only.

Operation and Engineering

There is a brick dwelling, about 300 ft. from the pumping station, for the use of the operator, who is also supplied with a motor boat. He is employed 12 months in the year and is required to send daily reports to the district engineer on the form (7¼x5½ in.) shown in Fig. 5.

Hartwell Drainage and Levee District
Greene County, Illinois

PUMPING RECORD

Weather ..... Month ..... Day ..... Year .....
Rainfall ..... Inches 191

	Hours Run	Time of Running	Pulley No.	R. P. M.	Approximate Amperage
Pump No. I					
Pump No. II					
Pump No. III					

Total Meter Reading 6:00 P. M. .....
K. W. H. used .....

River Gauge Reading 7:00 A. M. ..... Ft.
Ditch " " 7:00 A. M. ..... Ft.
River " " 6:00 P. M. ..... Ft.
Ditch " " 6:00 P. M. ..... Ft.
Average head ..... Ft.

Caldwell Engineering Co.
Engineers
Jacksonville, Illinois

Operator

FIG. 5. DAILY-REPORT FORM, HARTWELL STATION

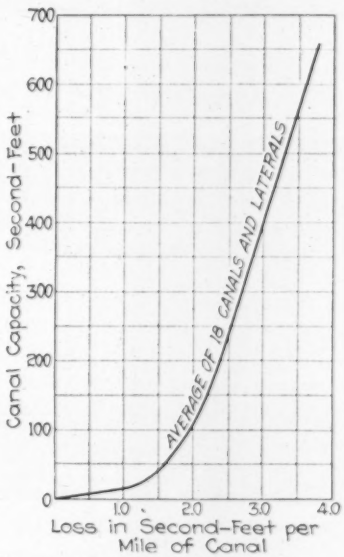
These works were designed by H. L. Caldwell, Chief Engineer of the Caldwell Engineering Co., Jacksonville, Ill., and were built under the supervision of S. J. Dalton, Jr., Field Engineer. The contractors were as follows: Levee reinforcing, Barston & Millard, Peoria, Ill.; pumping station, Arrow Engineering Co., St. Louis, Mo.; gravity outlet, J. D. Weaver, Jacksonville, Ill.; ditches, R. H. & G. A. McWilliams, Chicago, Ill.

Transmission Losses in Modesto Irrigation Canals

By Kenneth A. Heron*

Where open unlined earth canals are used for the distribution of water in an irrigation system a large part of the water appropriated is lost in transmission between the source of supply and the farms. To determine just what this loss amounts to in the Modesto Irrigation District, in California, a series of measurements was made by me during the irrigation season of 1914.

Owing to the warm summer temperature and the sandy formations and soils of the district, the transmission losses were found somewhat higher than is ordinarily the case. These losses are divided into those from seepage, evaporation and leakage. The evaporation loss is such a small part of the seepage loss that no effort was made to distinguish between the two, which were combined and called seepage. The following general methods were pursued in determining the seepage losses. A time was selected when the flow of a lateral or canal had been constant for some hours. It was then measured with an A. Lietz current meter at the head, or at the high end of the portion of the lateral or canal section under observation. Measurements were made at points lower down after such periods of time as it was computed would be required by the same water that was last measured to reach the new measuring point. As some of the canal sections under observation were as much as nine miles in length an entire day was frequently required to obtain the measurements on one lateral. All visible losses from the canal, such as leaks through boxes, water turned out of the canal into another canal and leaks through banks, were carefully measured. Large irrigation heads (average 20 sec.-ft.) are used in this district, and consequently the flow in laterals is not subject to as many variations as is the case where a large number of small heads are drawn from a lateral. After the last measurement was made on the low end of the section under observation, it was ascertained if the intake discharge at the high end of the section had remained constant. Where any material change happened the measurements were repeated.



TRANSMISSION LOSSES BY SEEPAGE AND EVAPORATION

All the most important canal and main lateral transmission losses were checked by a system of daily gage readings and measurements, which were carried on throughout the season. As a result of all the measurements made, the accompanying curve has been drawn to show the average loss per mile in canals and laterals of various capacities. In a number of instances the results were quite different from what the curve would indicate, but cases of this kind were explained by local conditions.

It is thought that this curve represents average conditions in generally sandy areas such as exist in the San Joaquin and Sacramento Valleys in California.

*Irrigation Engineer, Modesto, Calif.

Industrial Accident Statistics—The industries which contribute the greater number of fatal accidents are railway employments and agricultural pursuits, each group being responsible for approximately 4,200 fatalities a year. Coal mining contributes more than 2,600, and building and construction work nearly 1,900. General manufacturing, while employing large numbers, produces only 1,800 fatal accidents. When the fatality rates are considered, metal mining ranks as most hazardous, with a rate of 4 per 1,000; coal mining coming next, with 3.5, and fisheries and navigation following with a rate of 3 per 1,000. Manufacturing industries as a whole rank lowest, with a rate of 0.25. The United States Bureau of Labor Statistics of the Department of Labor has just issued, as Bulletin 157, a report on this subject by Frederick L. Hoffman. The conclusion reached is that the number of fatal industrial accidents among American wage-earners, including both sexes, may be conservatively estimated at 25,000, and the number of injuries involving a disability of more than four weeks at approximately 700,000.

Revised Cross-Sections for Illinois Roads

By H. E. Bilger*

SYNOPSIS—An analysis of the highway problem of Illinois and the Middle West, where good local material for roadbuilding is scarce. Discusses how an attempt has been made to solve these problems as economically as possible by devising types of brick and concrete roads to fit rural conditions.

The proposed system of state-aid roads in Illinois comprises some 15,000 mi. and includes the main rural highways in each of the 102 counties of the state. With a construction problem of this magnitude and rapidly changing traffic conditions the important matter is not to complete the entire system within a specified time, but to construct in each locality roads of such types and dimensions as economically to satisfy present traffic requirements, and in addition be susceptible of reasonable modification to meet the requirements of the future.

SIX-FOOT EARTH SHOULDERS AND LARGE SIDE DITCHES FOR SURFACE DRAINAGE, 18-FT. CONCRETE ROAD, ILLINOIS HIGHWAY COMMISSION

In a state having a gross area of 55,000 sq.mi. there is such a wide variety of conditions as to admit the economical construction of very many different types of highway. Therefore it is not practicable, nor even desirable, to attempt the design of standard cross-sections to cover all the conditions encountered. Nevertheless, a certain number of these cross-sections constitute the group most frequently used, and which are termed "standard."

The necessary width of right-of-way is governed largely by the topographic conditions, but also by the type of the proposed improvements. On rural highways paved with brick or concrete there can be found no condition in the proposed Illinois state-aid system that will properly admit of a right-of-way narrower than 40 ft. It is highly desirable that the minimum width of right-of-way for all main traveled county roads be 50 ft. Cuts and fills will in many cases require a width of 60 or 70 ft., or even more.

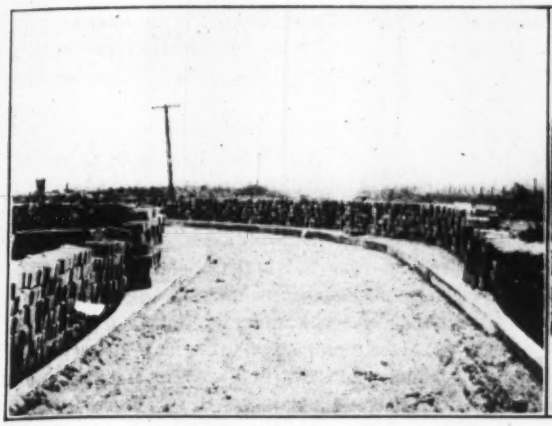
Where a highway crosses a valley it is particularly desirable that the width of right-of-way be ample to afford space for borrow-pits, in order that the necessary material may be provided economically for the construction of the embankment. For this additional width the cost of farm land, even at $300 or $400 an acre, is almost negligible when compared with the expense necessarily incurred where filling material must be moved for a distance of over 300 ft.

Since the true function of a highway is not the transportation of freight at a minimum cost, it is evident that great expense in making grades easier than about 3 per cent. is not warranted by traffic considerations alone. Excessive cuts in order to provide an easy gradient through ordinary ridges merely add difficulties to the drainage problem.

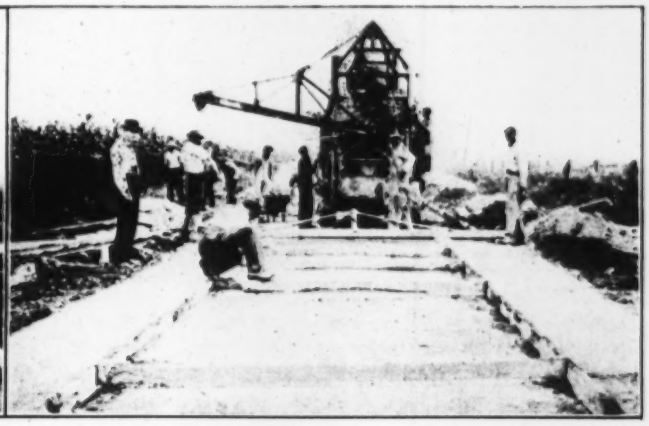
Except for comparatively short lengths over ridges, it is particularly desirable that the width of graded roadway be not less than 28 ft. in order to provide for the maintenance of an earth road on each side of the pavement, where this has only a 10-ft. width. For probably at least nine months of the year weather conditions in Illinois admit of the economical maintenance of an earth road to a degree of perfection that induces the greater portion of the traveling public to abandon the pavement.

If the graded roadway is less than 28 ft. in width it becomes necessary to construct the pavement off the center line of the highway and have the entire earth roadway on one side. One objection to this is that in going in a certain direction the loaded vehicle on the pavement is

*Road Engineer, Illinois State Highway Department, Springfield, Ill.



BUILDING 3-FT. CONCRETE SHOULDERS AT CROSS-ROADS



WIDENING CONCRETE SHOULDERS TO 3 FT. AT CROSS-ROADS

required to take to the earth road almost entirely, for the vehicle coming in the opposite direction has practically no opportunity to turn out, even though it be empty. A counteracting objection to a pavement on the center line is the necessity for maintaining two parallel earth roads.

It yet remains to be proved whether it is more economical to maintain an earth road 15 ft. wide, and accommodating traffic in both directions, than to maintain two earth roads each 9 ft. wide. Considering the possibilities of future development, it would seem that the pavement should be at least approximately in the center of the highway.

Wherever practicable the side ditches are constructed with a 2-ft. horizontal base 2 ft. lower than the crown of the finished pavement. The horizontal base is not always economically practicable, but is dependent largely upon the character of the soil and also upon the contractor's facilities for doing the work. A V-ditch is about 6 in. deeper than the flat-bottom ditch. Its additional capacity is practically negligible, but under certain soil and other conditions it can be more economically built by machine work than the flat-bottom ditch.

For short stretches over ridges the width of the graded roadway may economically be narrowed to about 18 ft. as a minimum, if provision is to be made for two lines of traffic. The practicability of this construction depends largely on the omission of deep ditches on the ridges, where but a very small amount of water needs to be taken care of by the surface drains.

Discussion of New Cross-Sections

Cross-Section 1—The 10-ft. concrete pavement is particularly applicable for light or medium horse-drawn traffic, where the loaded vehicles move largely in one direction and the pleasure vehicles are more or less equally divided with respect to their direction of travel. Except for a small amount of slow-moving traffic, 10 ft. is the narrowest width a concrete pavement should ever have in Illinois, even on a level tangent.

Concrete pavements which are only about 8 ft. wide, where the coarse aggregate used is of sedimentary origin, readily yield along the wheel tracks under moderate steel-tired traffic. The 10-ft. width affords more or less opportunity for distribution of the wear, and consequently this width of pavement is more durable. The combination of conditions that make the adoption of a 10-ft. cross-section advisable is not so common in Illinois as might be inferred from the general preference given it by officials in many of the counties.

Durability and Width of Pavement

Inasmuch as the durability of a concrete pavement is measured largely by the wearing qualities of the coarse aggregate used, it is evident that under Illinois conditions, where practically the only coarse aggregate available is limestone or dolomite, there are no very strong arguments for a 10-ft. concrete pavement where horse-drawn traffic is heavy. Were diabase or other forms of good igneous rock available, the situation would be somewhat modified. A sandy clay soil for the shoulders favors a 10-ft. width, while gumbo and buckshot soils discourage its adoption.

Cross-Section 2—This is identical with cross-section 1, except that the roadway is on a fill and is only 28 ft. wide. The reason for the reduction of the width is to meet the many cases that arise where funds are not available for more expensive first-cost construction, and also to keep the embankment within the limits of the highway.

Cross-Section 3—The use of this cross-section is intended to be confined to short lengths of road over ridges. Excessive expense due to excavation is avoided by providing a graded roadway only 18 ft. in width, and by meeting the drainage requirements with concrete gutters. This cross-section virtually provides an 18-ft. roadway,

CONCRETE GUTTERS OF 16-FT. BRICK ROAD

since the shallow concrete gutters take the traffic as well as the pavement proper. This construction is adopted only where little water is to be cared for.

Heretofore this cross-section was designed with grouted macadam gutters, but the impracticability of constructing gutters of a type other than that of the pavement was soon demonstrated. While the 15-ft. concrete pavement is being laid there is but little additional labor expense incurred in laying the concrete gutters as a part of the pavement.

During construction the placing of the concrete in the pavement proper is always just a few feet in advance of the gutter. The thin forms along the line of the pavement proper are removed as soon as the concrete for the gutters has been placed; consequently they become part of the pavement. The economy of this cross-section is not at once appreciated from the office point of view, but becomes established when considered from the contractor's viewpoint.

The grouted macadam gutters cannot be constructed simultaneously with the pavement because time has to be given for the concrete to season. This delay, in addition to the new labor operations, equipment, etc., to be employed in constructing the grouted macadam gutters, practically demands the substitution of concrete.

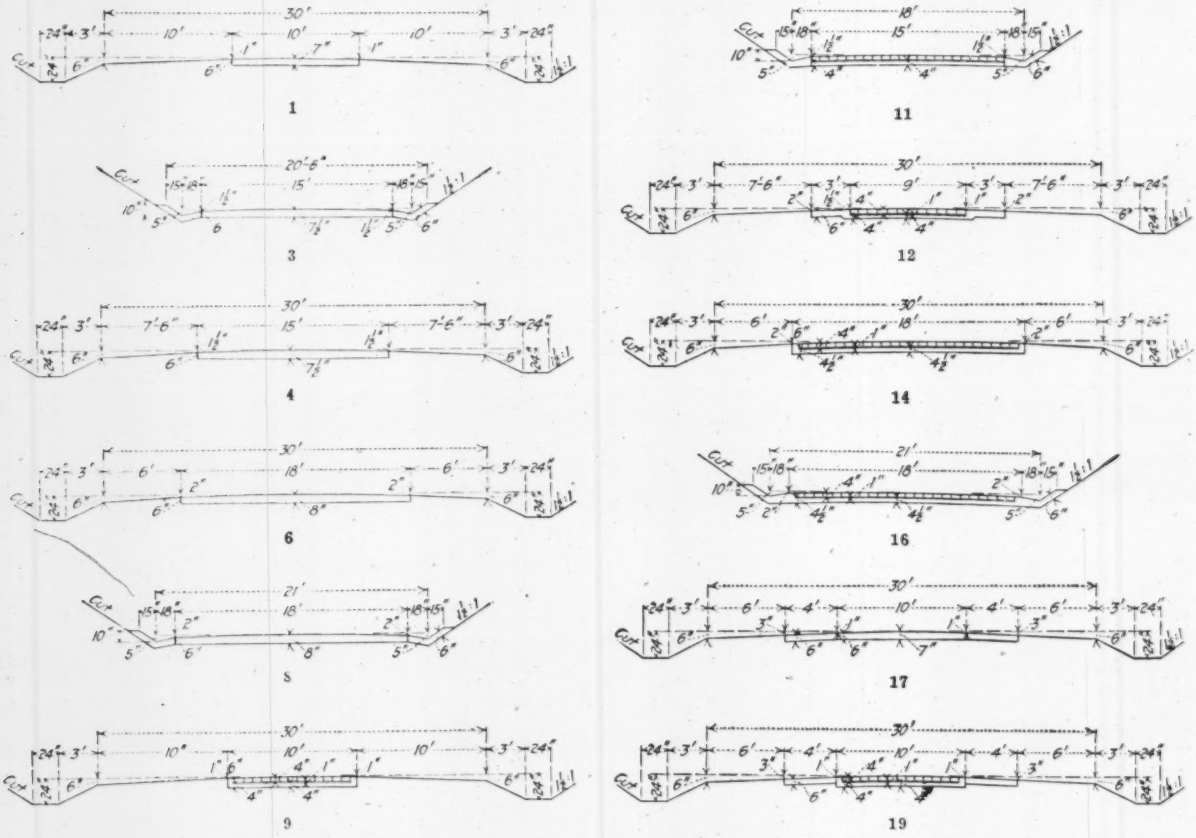
This cross-section is applicable for all motor-traffic conditions and for all reasonably heavy horse-drawn traffic conditions where there are two lines of traffic.

Cross-Section 4—The 15-ft. width of concrete pavement is rapidly growing in favor in Illinois. This width satisfactorily admits of two lines of horse-drawn traffic, and answers with more or less satisfaction the requirements of two lines of motor traffic at normal speeds when such traffic is not very dense.

Cross-Section 5—This is practically identical with cross-section 4, except that it is for a roadway on an embankment 32 ft. in width. The most developed areas of Illinois require a graded roadway, even on comparatively high embankments, of not less than 32 ft. in width. These cross-sections are not strictly consistent, but are designed to meet local requirements and preferences.

Cross-Section 6—Except under extremely dense traffic conditions, cross-section 6 owes its existence entirely to the motor vehicle. For two fast-moving lines of motor traffic safety requires that the width of the pavement be not less than 18 ft. An 18-ft. concrete or brick pavement constructed on a highway upon which there has never been a pavement of any kind can only mean a sudden revolution of traffic conditions. Logically this type would be reached by successive developments of less expensive construction and of narrower widths.

Cross-Section 7—This is identical with cross-section 6, except that the roadway is on an embankment and is 32 ft. in width.

Cross-Section 8—Like cross-section 3, this is especially applicable for short lengths over ridges. The virtual roadway is 21 ft. It would seem that conditions are not frequently encountered that would warrant the adoption of this cross-section, because of the additional width provided.

NEW ROAD CROSS-SECTIONS NOS. 1 TO 19, ILLINOIS HIGHWAY COMMISSION

Cross-Section 9—It will be noted that, beginning with cross-section 9, the variation from the preceding cross-sections is confined almost entirely to the character of the pavement. In addition to being applicable under all conditions noted under cross-section 1, it is also suitable for the most severe horse-drawn traffic to be found in any rural community in Illinois.

As a rough average it has been found that the contract price of the pavement proper (cross-section 9) over and above that of the concrete cross-section 1 is about 70c. per sq.yd. Cross-section 9 makes use of local aggregates for the concrete, which as a rule are less expensive than the imported. Local sand, gravel and stone in Illinois are not always acceptable for concrete pavements, but with judgment they can usually be employed with safety and economy in the construction of concrete bases for brick.

A probable additional point in favor of cross-section 9 is that its width may be readily increased at any time future conditions demand. The probable life of a brick pavement is such that while only a 10-ft. width is originally warranted, its future widening may be accomplished while the pavement is still far from worn out.

Cross-Section 10—This is identical with cross-section 9, except that the roadway is on an embankment and is only 28 ft. in width.

Cross-Section 11—This corresponds with cross-section 3. The virtual roadway provided is 18 ft. in width. The remarks relating to the concrete gutters of cross-section 3 apply also to this type. The concrete gutters are constructed as a part of the concrete base and are of the same materials and mixture. Considering the small amount of traffic that comes upon these gutters, and also the fact that much of this is motor traffic having rubber tires, it is quite probable that the length of life of the gutters approaches that of the brick pavement.

Cross-Section 12—This is a development of the narrow brick pavement with macadam shoulders. As in the construction of grouted macadam gutters, it was found in practice that gravel or macadam shoulders are not often economical or advisable in conjunction with a brick or concrete pavement. All materials employed and all operations of construction throughout the entire width of pavement should be identical so far as practicable.

The 3-ft. concrete shoulders are constructed as a part of the base. The mixture for the concrete base is 1 : 3½ : 6, whereas the mixture for the shoulder is 1 : 1¾ : 3. By adopting this mixture for the shoulders the ratio of fine to coarse aggregate remains constant, while exactly twice the amount of cement is required in one batch for the shoulders as in one batch for the base. This simplifies construction operations.

It is anticipated that cross-section 12 will provide the substantial equivalent for the 15-ft. brick pavement and at somewhat less expense. Probably more than 80 per cent. of the horse-drawn traffic will naturally be confined to the 9-ft. width of brick, and the use of the concrete shoulders will be largely for passing.

Cross-Section 13—This cross-section is identical with cross-section 12, except that the roadway is on an embankment and is 32 ft. in width.

Cross-sections 14 and 15—These are types which are demanded by actual necessity in extremely few rural communities in Illinois. Cross-section 15 is identical with cross-section 14, except that it is on a fill and is consequently 32 ft. wide.

Cross-Section 16—With cross-sections 14 and 15, this is representative of as durable a type of rural highway improvement as is commercially possible in Illinois.

Cross-Section 17—Except for rare occasions, this cross-section is destined soon to become obsolete. Cross-section 18 is identical with cross-section 17, except the width of roadway, which is 32 ft.

Cross-Section 19—The macadam shoulders are destined soon to be entirely abandoned, as also in cross-section 20, which is identical with cross-section 19, except the width of roadway, which is 32 ft.

Conclusions—A road cross-section can be designed intelligently only in the light of all the conditions peculiar to the locality in which the road is to be built. Economic procedure in rural highway improvement is measured by the degree of thoroughness of the analysis of the local conditions, and in strict compliance with those conditions.

The work of the Illinois State Highway Department is carried on under the direction of William W. Marr, Chief State Highway Engineer, with whose approval the foregoing is published.

Longitude Determinations of Great Accuracy

By Owen B. French*

During the summer of 1914 the United States Coast and Geodetic Survey determined three differences of longitude with a higher order of accuracy than had been obtained previously. The work was done in coöperation with the Royal Prussian Geodetic Institute of Potsdam, Germany, for the purpose of furnishing a more accurate connection between the longitude nets of America and Europe, and also to secure data sufficiently accurate to show any possible change in the relative positions of the two continents.

When this work was first considered in March, 1912, it was proposed to make the new determination by wireless telegraphy. The observers were to determine the difference of longitude between Cambridge, Mass., and the Azores Islands, using signals sent from Glace Bay, Canada; while German observers were to make the determination between the Azores and Potsdam, Germany, using signals sent from the wireless station at Clifden, Ireland. The distances between the sending stations and their receiving stations are practically equal, so that the time of transmission would be eliminated.

The difficulty in securing suitable recording apparatus for wireless signals and several other considerations caused the abandonment of this plan and the substitution of the method by cable between Far Rockaway, Long Island, N. Y., and Borkum, Germany, including an accurate connection with the longitude net at each end of the cable.

The connection of the cable station at Far Rockaway, N. Y., with the longitude net of the United States was accomplished by Fremont Morse and Owen B. French, of the United States Coast and Geodetic Survey. Two old stations, Harvard College Observatory, Cambridge, Mass., and New Naval Observatory, Washington, D. C., were used for this connection, with a new direct determination also between the old stations, the old work having been done before the transit micrometer came into use in the Coast and Geodetic Survey. Harvard Observa-

*Assistant, Coast and Geodetic Survey, Washington, D. C.

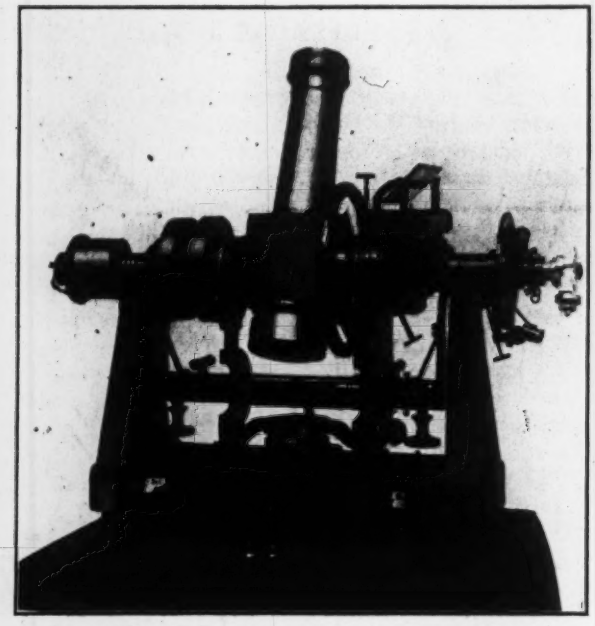


FIG. 1. MOST RECENT TYPE OF TRANSIT INSTRUMENT FOR LONGITUDE DETERMINATION

tory is considered as the initial station for all United States longitudes, as all the old transatlantic longitudes have been connected with it.

New instruments, made by Bamberg, of Berlin, Germany, were received by the Coast and Geodetic Survey just before this work was begun and were used here for the first time. The transits are of the broken-telescope type, with the eyepiece and transit micrometer at one end of the axis (Fig. 1). The frame supporting the telescope axis is low and very rigid, having two supporting screws at either end of one side and a third screw in the middle of the other long side. Although this method of supporting an instrument causes a disturbance of the azimuth whenever the axis is leveled, the instruments proved very stable. The field of the telescope being sufficiently large, the telescope was reversed in the middle of the observation on each star, thus eliminating the necessity for considering collimation and pivot inequality.

The chronographs for receiving the records, made by Fuess, of Berlin, Germany (Fig. 2), are of the fillet type, with electric control for starting and stopping. The whole apparatus was so arranged and wired that the observer could control all the electric circuits while sitting at the telescope without touching the instrument or pier. The electricity for operating the various relays and illuminating the field of the telescope was furnished by dry cells.

At Cambridge and Washington the standard observatory clocks were used. At Far Rockaway the German clock was used for the United States work as well as for the cable work. All the clocks were kept at practically a constant temperature.

The differences of time resulting from this work are:

	Min.	Sec.	Sec.
Cambridge to Far Rockaway.....	10	29.031	±0.0031
Far Rockaway to Washington.....	13	15.704	±0.0028
Cambridge to Washington.....	23	44.738	±0.0024

The error of closure is 0.003, which is smaller than might be expected from the probable errors shown in the last column. These probable errors are not inferior to those obtained in any foreign country and are about half as large as the best previously obtained by the United States Coast and Geodetic Survey, which has charge of all primary longitude work in the United States.

The foregoing results depend upon observations made on eight to ten nights for each line. Errors of star-place were eliminated by observing the same stars at both stations of each line. Three time sets, each consisting of five or six time stars and an azimuth star, were observed each night with two exchanges of signals between stations. The observers exchanged stations near the middle of the observations on each line, each taking his instruments with him every time, thus making the final results practically free from personal equation.

The personal equations on the three lines are: +0.020, —0.001 and +0.004 sec. The first may be considered as due partly to the instruments being new and not in perfectly smooth working condition and slightly to inexperience of the observers with this style of instrument. These observations, therefore, confirm previous statements that observations made with the transit micrometer practically eliminate the need for considering personal equation between the observers.

The old value for the difference of longitude between Cambridge and Washington agrees exactly with the value given. This must be classed as accidental when we consider that the old value was based upon two lines, one of which received a correction of 0.031 sec. and the other of 0.010 sec. in the adjustment of that work. However, the old longitude determinations are of a high order of accuracy, where there was an exchange of observers, as has been shown by several comparisons with work by modern instruments.

In view of the statement that this work was undertaken partly for the purpose of showing a possible change in the relative positions of the two continents, it may be interesting to note that the results recently obtained by observers of the United States Naval Observatory for the difference of longitude between Washington and Paris, using wireless telegraphy, agree more closely with the old transatlantic longitudes than might be expected from the probable errors of the old results, and do not differ enough to furnish proof regarding any change in position of the continents.

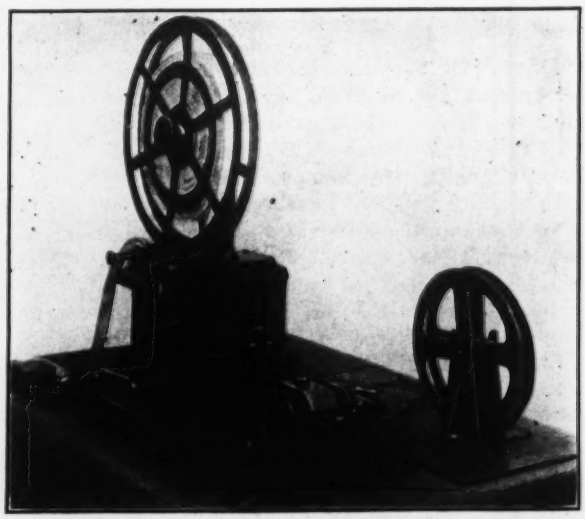


FIG. 2. RECORDING INSTRUMENT FOR LONGITUDE DETERMINATION

Building the Mathis Dams--II

By E. Lauchli*

SYNOPSIS—Notes on the design and construction of a dike dam built upon a reinforced-concrete mattress and having a very deep reinforced cutoff wall. Effect of ground-temperature differences on cutoff-wall stresses.

In creating the Mathis reservoir a small dike dam across a depression leading from the basis was required in addition to the main dam across the Tallulah River. Various structures were considered for closing the gap. One was an earth fill with reinforced-concrete core wall; but this was abandoned for lack of proper material. The soil at and near the site consisted of sand mixed with a very little clay and decomposed mica schist. A masonry dam of the gravity type was out of the question owing to lack of adequate foundations. The design of a reinforced-concrete structure was then prepared, with a cutoff wall 10 to 15 ft. deep and buttresses resting on spread footings.

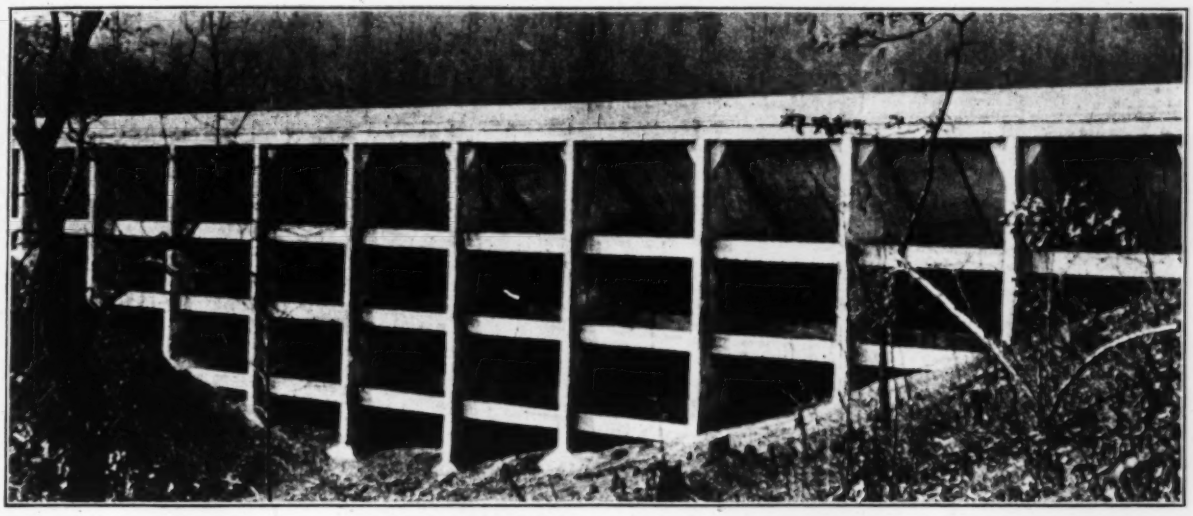


FIG. 1. DOWNSTREAM VIEW OF MATHIS DIKE DAM

Reinforced-Concrete Dam Selected

While this design was being elaborated test pits sunk at various points of the proposed cutoff wall revealed the fact that rock was not available except at great depth, and that the material penetrated was chiefly of the kind referred to before, together with loose rock which weathered rapidly on exposure.

The design was therefore modified to suit these new conditions. The buttresses were spaced 18 ft. c. to c., and instead of spreading their footings, a heavily reinforced concrete mattress was provided (1) to reduce the pressure on the subsoil, (2) to avoid unequal settlements, (3) to prevent the buttresses on the side slopes from moving sideways, and (4) to increase the stability of the structure against sliding.

The pressure on the foundation is uniform with the reservoir empty. With water at El. 1692 (3 ft. allowance being made above maximum level for wave action) the pressure at the heel and toe of the dam is 920 and 1,370 lb. per sq.ft. respectively. The friction coefficient against sliding is 0.47. However, in order to further increase the stability of the structure against sliding, a longitudinal reinforced-concrete rib was provided at the toe and another at the center of the lower side of the mattress. The latter is reinforced with 1-in. corrugated steel bars, placed so as to take care of positive and negative moments. Near the buttresses the depth of the mattress is increased to take care of shearing stresses.

Care was taken to exclude the possibility of water pressure under the mattress. To this end, the cutoff wall was carried down to rock 30 to 57 ft. (except at one end) and its junction with the mattress and deck was amply reinforced. Weep holes were left through the mattress.

Design of the Buttresses and Decks

The buttresses were made of 1:3:6 concrete (the design allowed 300 lb. per sq.in. for concrete in compression and 100 lb. for shear). From the mattresses up to El. 1670 the buttresses are 16 in. thick, and 14 in. above that elevation. Although 10 in. would have been ample to resist the stresses, it was found advisable to increase the thickness to provide ample working room.

When pouring one of the last buttresses, a mixture of 1:2:4 concrete was used. This showed that economy in labor would result by using a rich mixture for work of this kind, as much spading and finishing could thereby be avoided.

The decks were made of 1:2:4 concrete (unit stresses of 600 lb., 60 lb. and 14,000 lb. per sq.in. being allowed for concrete in compression and shear and for tension in steel respectively). As little information was available on the corrosion of steel reinforcement embedded in thin concrete slabs subjected to hydrostatic pressure, it was decided to curve the lower side of the deck, thus making each slab an arch capable of bearing the hydro-

*2 Wall St., New York City.

static pressure, in case of any depreciation of the steel reinforcement which might take place in course of time.

The decks are free to expand or contract horizontally, and strips of asphalted felt are provided between the deck and the haunches so as to insure watertightness. The abutting surfaces of the buttress tongues and of the decks are painted with asphaltum.

Ground Temperature Variations

During construction the question arose as to the possibility of vertical temperature cracks developing in the

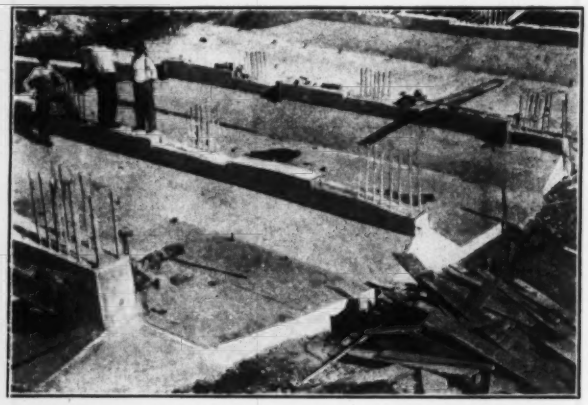


FIG. 2. FOUNDATION MATTRESS FOR DIKE DAM

cutoff wall, which cracks might enable water to find its way under the mattress. The writer carried on a series of observations in bore holes 2.5 to 45 ft. deep to ascertain the variation between ground and air temperature in the vicinity of the structure.

The ground temperature, even in December, at the bottom of the 45-ft. hole was found to be constant at 61.5 deg. F., which is 2.5 deg. higher than the average yearly air temperature here. The temperature recorded at the bottom of the 16-ft. hole ran from 53 to 56 deg. F. It was anticipated that the upper part of the cutoff wall would be subjected to nearly the same temperature variations as water in the reservoir—that is, from about 34 to 60 deg. F. Therefore the upper 15 to 20 ft. was reinforced with $\frac{5}{8}$-in. vertical rods spaced about 2 ft. c. to c. and with 1-in. horizontal rods spaced 12 in. c. to c. At 2.5 to 3 ft. the ground was subjected to practically daily temperature variations; therefore the concrete mattress, in spite of its heavy steel reinforcement, was covered with 3 ft. of earth, so as to minimize the effect of temperature changes.

The decks are of course fully exposed to temperature variations, but are free to expand or contract horizontally. In certain instances, with the reservoir empty, the joints opened from $\frac{1}{16}$ to $\frac{3}{16}$ in. per panel. The beams between buttresses were poured during the summer of 1913. The maximum air temperature was about 110 deg. F. in the sun. During the winter of 1913-14 the minimum air temperatures were from 12 to 15 deg. F., yet only hair cracks were apparent in a few beams.

Methods of Construction

One wooden derrick with a 60-ft. boom and one steel derrick with a 100-ft. boom handled the material excavated from the cutoff trench. The excavation was made with picks and shovels, no blasting being required. The sides of the trench stood well, requiring no bracing or sheeting, even when 57 ft. deep. However, no chance was taken, and enough bracing was provided to protect the crews against a possible cave-in. After rock had been reached, drills were put to work in order to ascertain the nature of the underlying rock. Except in a few instances, a soft solid rock was encountered which disintegrated rapidly when exposed. All bore-holes, except Nos. 8, 9, 10, 11 and 20 (Fig. 4) were carried down with machine drills, the others being churned.

After holes No. 7 and No. 8 had been put down, it was feared that no rock could be found except at great depth, thus necessitating much excavation and concrete, and an attempt was made to drive steel sheetpiling, as shown in Fig. 4. The result obtained can hardly be called successful, and only about 50 lin. ft. was used. It was then decided to provide all test holes with grout pipes, extending these to the surface of the ground, on the downstream side of the deck and to grout the holes under high pressure, should leaks develop with the reservoir full.[1]

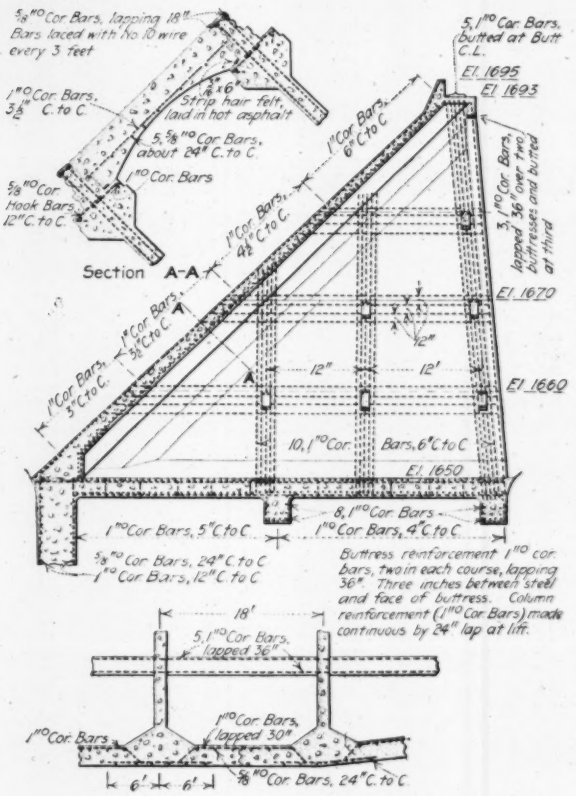

5/8" Cor. Bars, lapping 18". Bars laced with No. 10 wire every 3 feet
5, 1" Cor. Bars, butted at Butt C.L.
El. 1695
El. 1693
1" Cor. Bars, 3" C. to C.
8" x 6" Strip hair felt, laid in hot asphalt
5, 5/8" Cor. Bars, about 24" C. to C.
1" Cor. Bars
1" Cor. Bars, 6" C to C
5/8" Cor. Hook Bars, 12" C. to C.
1" Cor. Bars, 42" C. to C.
3, 1" Cor. Bars, lapped 36" over two buttresses and butted at third
Section A-A
El. 1670
1" Cor. Bars, 5" C. to C.
12"
12"
12"
El. 1660
1" Cor. Bars, 5" C. to C.
10, 1" Cor. Bars, 6" C. to C.
El. 1650
8, 1" Cor. Bars
1" Cor. Bars, 4" C. to C.
1" Cor. Bars, 5" C. to C.
5/8" Cor. Bars, 24" C. to C
1" Cor. Bars, 12" C. to C.
Buttress reinforcement 1" cor. bars, two in each course, lapping 36". Three inches between steel and face of buttress. Column reinforcement (1" Cor. Bars) made continuous by 24" lap at liff.
18'
5, 1" Cor. Bars, lapped 36"
1" Cor. Bars, (lapped 30"
1" Cor. Bars
6'
6'
5/8" Cor. Bars, 24" C. to C

FIG. 3. DETAILS OF MATHIS DIKE DAM

The cutoff wall was concreted in sections, between wooden bulkheads, the abutting surfaces of the concrete sections being tongued and grooved. A 1:3:6 mixture was used, one-man stones being embedded in it.

The concrete plant (see Fig. 2 of Part I of this article) consisted of a ½-yd. cube mixer, located about 30 ft.

[1]After construction was completed and the reservoir filled to maximum level, the grout-pipe caps were removed and it was found that half of the pipes would discharge from 0.5 to 12 gal. per min. They were then grouted under a pressure of 70 to 85 lb. In general they took comparatively little grout—one to four sacks of cement each, although one or two pipes took from 12 to 16 sacks.

back of the cutoff wall, at the center of the structure. The concrete was handled with derricks, from the mixer to the forms, in special buckets on a car rolling back and forth over a track laid on the top of the buttresses. A 1500-ft. cableway conveyed crushed rock and sand from a construction railroad, 1¼ mi. long, connecting the Tallulah Falls R.R. with the crusher plant at the main dam, a quarter mile above.

About 180 cu.yd. of concrete was laid per week, the maximum being 478 cu.yd. The whole structure involved 4523 cu.yd. of concrete and 288,830 lb. of reinforcing steel—that is, 64 lb. of steel per cu.yd. of concrete. An average of 12,600 lb. of steel was laid per week (six days) and a maximum of 26,000 lb.

As negro labor was used almost exclusively, the inspection was made very rigid, no concrete being laid in the absence of inspectors. The mattress was concreted in sections 18 ft. wide between construction joints located half way between buttresses, beginning with the lowest section. The buttresses were concreted up to a height of 3 or 4 ft. together with the mattress; after that in 10-ft. lifts. The cross struts were poured usually a week or two after a buttress lift.

Timber forms were used throughout; but the arch forms for the lower side of the decks were lined with sheet iron. The decks were concreted in panels extending from buttress to buttress and in lifts of about 10 ft. A 1:2:4 concrete was used in the mattress, decks and cross-beams, and 1:3:6 in the balance of the structure. The specifications called for stones passing through a 2-in. and 2½-in. mesh for the respective mixtures.

The cost of this structure, involving 3100 cu.yd. of excavation and 4523 cu.yd. of concrete, was approximately $75,000, the cost of excavation and concrete being $3.40 and $14.45 per cu.yd. respectively. Cement cost $1.823 per bbl.

C. O. Lenz, Chief Engineer of the Georgia Railway and Power Co., was responsible for the engineering work on the entire Tallulah Falls power development. The late John Birkinbine was retained as consulting engineer on the reservoir project. C. G. Adsit was in charge of the construction work at the Mathis basin with H. T. Hartwell as resident engineer. The writer was in charge of the design of the two dams at Mathis and supervised their construction. The Hardaway Construction Co. was the subcontractor on the dams.

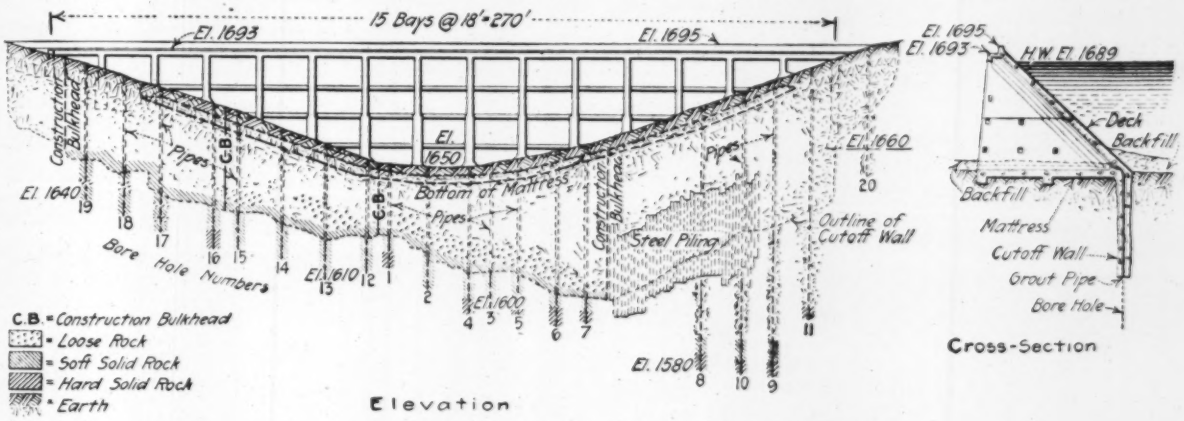


FIG. 4. ELEVATION OF MATHIS DIKE DAM AND FOUNDATIONS

State Control of Sewage-Treatment Works*

As the great majority of sewage-treatment works in America are small and frequently widely separated, it is apparent that the needed expert supervision cannot be obtained locally and that efficiency of operation can only be secured through some central authority. In several states the legislatures have empowered the state boards of health with authority to control the pollution of water-their approval is required before sewerage works can be constructed.

In municipalities where sewage treatment is intrusted to competent, expert employees and where this work has the strong moral and financial support of the citizens, the exercise of state authority and supervision is but little needed. But in such cases the coöperation of state and municipal officials is of mutual advantage.

For the state boards of health to act intelligently they should know the methods of operation and the results accomplished in all the sewage-treatment works in the state. They would then be able to act as clearing houses, supplying to one works the information obtained from several others operating under similar conditions. Such information must, of course, be applied to any particular works by one who is thoroughly conversant with local conditions and able to distinguish the peculiarities and differences involved. The operation of each works is a purely individual matter. Blindly copying, without due analysis of the local conditions, is generally fatal.

The state is interested in seeing that the existing works accomplish the best results possible, and the separate communities are naturally anxious that the works shall meet the requirements at the minimum expense for operation, additions and renewals. To this end, information is required on the following:

1. The purpose of the works; that is, are they primarily intended to protect sources of water-supplies or to prevent the creation of nuisance?
2. The construction of the works; that is, the details of each process that influences operating methods, rather than the stability of the structure.
3. The quantity and character of the sewage to be treated.
4. The methods of operation and the results accomplished.

*From a report of the Committee on Works Operation and Analytical Methods to the Sanitary Engineering Section of the American Public H alth Association, Rochester, September, 1915. The committee was composed of W. L. Stevenson, chairman, C. B. Hoover, F. E. Daniels and four others.

It is practically impossible to recommend a standard form of report blank to cover the many types of apparatus used in sewage treatment. If, however, the report form for each works in a state is prepared to meet the local needs, it can still contain essential data so recorded that reports of operation of similar types of apparatus in different works will be in identical form for comparison.

In preparing such forms it should be borne in mind that the small works are generally operated by employees lacking a technical education, and therefore clearness and simplicity should be obtained by having as much as possible printed, leaving only figures to be filled in.

It is again desired to call attention to the importance of recording essential data. In the majority of sewage-treatment works no provision is made to obtain a record of the rate of flow to the plant, even though such information is vital to proper operation. The committee strongly recommends that engineers in designing new works provide means for easy measurement of the flow and that measuring devices be installed in existing works not now so equipped.

Railway Coal-Storage Plants

Two widely different types of coal storage and handling plants for railway coal supply are described below, and in both of these the coal is stored in open piles.

The deterioration of coal in open piles is not a serious consideration, according to a report to the International Railway Fuel Association by a committee of which Hiram J. Slifer, consulting engineer, Chicago, is chairman. But the coal should be carefully studied to determine the best methods of preventing spontaneous combustion, and it is advisable to store that from different fields in different piles. The report stated that various investigations have shown that with most coals there is very little difference in the heating value whether stored in the open or under cover, while objections to a covering are the increased cost of the plant and probable interference with the handling of the coal.

Louisville & Nashville Railroad Plant

The coal-storage plant designed for the new Radnor yard of the Louisville & Nashville R.R., at Nashville, Tenn., comprises a semicircular coal pile, which is divided by a semicircular track for a locomotive crane.[1] The coal can be filled in over the ends of the track, leaving only a pocket for the crane. The general arrangement is shown in Fig. 1. This plant will serve both the Louisville & Nashville and the Nashville, Chattanooga & St. Louis railroads. The storage pile will contain about 12,300 tons for the former and 8200 tons for the latter, while the coaling station for locomotives will have a 600- and a 400-ton bin for the two roads respectively.

The crane will travel on two tracks of 29¼-in. gage, spaced 18 ft. 11 in. c. to c., and will be mounted on four four-wheel trucks, thus having ample stability for swinging. It will have a long braced steel boom, carrying a 5-yd. grab bucket and having a maximum radius of 110 ft.

Coal will be received in hopper-bottom cars and dumped into a track pit, from which it may be fed directly to the vertical bucket hoist of the coaling station, or it may be picked up by the locomotive crane and deposited on the storage pile. To supply the coaling station the crane takes coal from the pile and drops it into the pit, filling it to such height that the coal will flow by gravity into the automatic feeders of the bucket hoist.

The coaling station will be of reinforced-concrete, with a hoist tower of structural steel. It will serve three engine tracks. In addition to the coal bins, it will have storage for 75 tons of green sand and 10 tons of dry sand. The coal and sand will be raised by duplicate balanced buckets at the rate of 125 tons per hour for both buckets. It will be provided also with four steel weighing hoppers of 15 tons' capacity. The crane will be operated by steam and the hoists by electricity.

A coal-storage and coaling plant of the same type is in operation at Paris, Ky. This has a crane of 80-ft. radius (with 3-yd. bucket) and travels on a single track

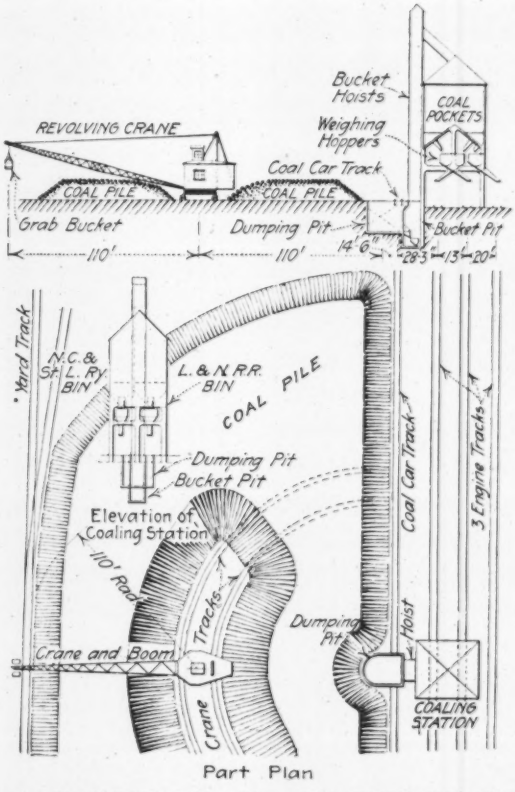


FIG. 1. COAL-STORAGE AND COAL-HANDLING PLANT WITH 110-FT. REVOLVING CRANE AT THE RADNOR YARD, LOUISVILLE & NASHVILLE R.R.

of 15-ft. gage. The coaling station has only a single bin of 400 tons' capacity, and has no weighing hoppers or sand-handling equipment. A similar plant with 110-ft. crane and 600-ton bin is being installed at Lebanon Junction, Ky. The plant at Paris has not been in use long enough (and has not handled enough coal) thoroughly to test the operation and advantages of the scheme, but it is satisfactory as to its mechanical operation. The only special features of the coaling stations used in connection with these storage plants are the open-back dumping pit

[1] This system, with a long-radius locomotive crane running on circular (or segmental) tracks, is patented by the Link-Belt Co., which supplied the cranes for the Louisville & Nashville R.R. here described.

and the unusual depth of the feeder and bucket-hoist pit. The cranes were built by the Link-Belt Co., and the coaling-station machinery by the Ogle Construction Co., of Chicago. The plants were designed and built under the direction of W. H. Courtenay, Chief Engineer of the Louisville & Nashville.

Southern Railway Coal Storage

Several reinforced-concrete coaling stations have been built recently by the Southern Ry., and at three of these provision is made for storing a supply of coal on the ground and handling this by means of drag-line buckets. The storage piles contain from 3000 to 10,000 tons each, with a depth of not more than 10 ft. The general arrangement of the plant is shown in Fig. 2.

The methods of delivering the coal to the storage pile and returning it to the coaling station are quite different from those at the Nashville plant already described. The railway cars dump the coal into a track hopper, from

The operation of the scraper bucket is effected by means of a double-drum friction hoist driven by a 25-hp. motor geared directly to the countershaft. The hoist and motor are mounted in a housing in the coaling station or on a steel platform over the coal-receiving track. From the drum a steel hauling cable extends to the bail on the mouth of the bucket. The backhaul cable extends to a block hitched to one of the posts and thence to its attachment to the back of the bucket, as shown.

With this equipment the operator can take the coal delivered from the chute and distribute it between this point and the post to which the snatch-block is attached. To reach the space between two posts, lines may be fastened to them and the snatch-block attached to the lines, as shown in Fig. 2. By shifting the block from pole to pole any point within the coal-storage area can be reached.

When it is necessary to supply the bin of the coaling station, the position of the bucket or scoop is reversed, its

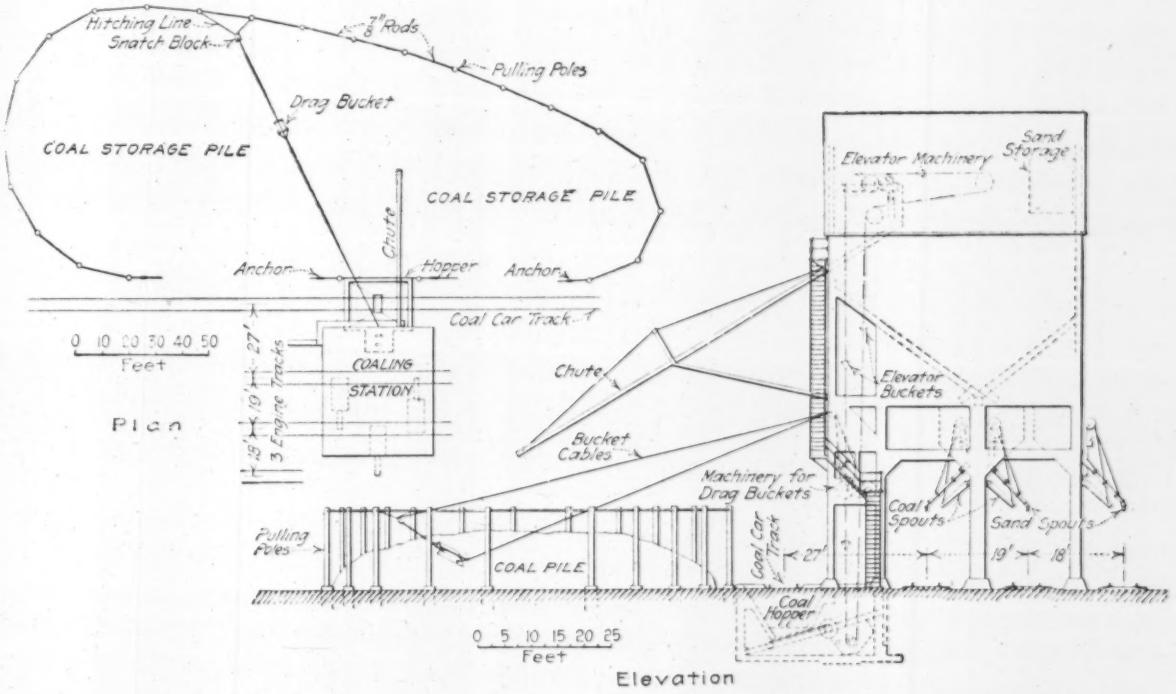


FIG. 2. COAL-STORAGE AND COAL-HANDLING PLANT WITH DRAG-LINE BUCKETS, SOUTHERN RY.

which it is fed by a loading device to an elevating conveyor of the bucket type. This delivers the coal either to the storage bin of the coaling station or to a gravity chute which discharges it at about the center of the storage pile. From this point it is distributed over the area of the pile by the drag scraper, which also delivers coal from the pile to the track hopper and elevator for the supply of the elevated coaling bin.

The storage pile is of irregular form and is surrounded by poles about 20 ft. apart for the attachment of the bucket lines. At the first plant these poles (termed pulling poles) were 20 ft. high, but it was found that poles of such height were not practicable without the use of outside guy lines, which would be undesirable. The height was reduced, therefore, to 12 ft. The poles are made of steel H-beams, each set in a concrete base. They are connected at the top by a row of 7/8-in. rods.

mouth (or open end) being turned toward the coaling station, as in Fig. 2, the backhaul cable then becoming the hauling line. In this way coal is carried from the storage pile to the receiving hopper, from which it is fed to the bucket conveyor and elevated to the bin. Each plant is equipped with at least two of these scraper buckets, thus minimizing the work of changing the blocks and tackle.

The coaling station shown in the drawing serves three engine tracks. The main bin has a capacity of 955 tons, and there are three scale pockets of 15 tons each, making a total of 1000 tons. It has also a sand-storage bin, with delivery spouts, so that engines can take coal and sand at the same time. The design of these coaling plants is under the direction of the maintenance-of-way department, and for information and plans thanks are due to H. W. Miller, Vice-President of the Southern Ry.

Laying Street-Railway Track Without Ties

By E. R. Horton, Jr.*

SYNOPSIS—The system of construction here described dispenses entirely with the use of ties. The rails are supported by reinforced-concrete girders, to which they are anchored at frequent intervals. Special features are the anchors, the use of continuous bed-plates under the rails, and the use of channel base plates to support the rail joints. The concrete is carried up to form the street paving along the tracks. The general purpose of the design is described and details of cost are given.

The type of track construction for paved streets which is here described, and shown in the accompanying drawings (Figs. 1 and 2), has been designed by the writer as the result of study and experience with low T-rails in concrete track paving on the lines of the Southern Public Utilities Co., of Charlotte, N. C. Acknowledgment is made to Edwin F. Taylor, general superintendent, whose coöperation has resulted in the adoption of this as the company's standard construction.

For the past five years the writer has been engaged in extending, reconstructing and paving the track systems of this company. The types of construction have been varied, but about 15 mi. has been concrete paving with 60- and 70-lb. T-rails. The ballasted cross-tie construction, with two-course concrete, has not been entirely satisfactory except in certain cases where conditions were favorable. Conclusions based upon both the successful and unsuccessful portions of the lines have resulted in the development of the present type. The most important of these conclusions may be stated as follows:

Concrete is satisfactory as track pavement when the track structure is not too flexible, and when very fine dust is excluded from the mixture. One of the most common causes of failure of track pavements is deflection of the rail; low T-rail will deflect on any yielding substructure to such an extent that the paving will be destroyed. Ballast when newly laid (and however thoroughly tamped and rolled) will shake down under traffic, and set up a wave motion in the rail. Therefore, where low T-rail is used, it must be so supported from beneath that the deflection will not be sufficient to injure the pavement. Reinforced concrete is most suitable for this purpose because it is permanent and will not settle.

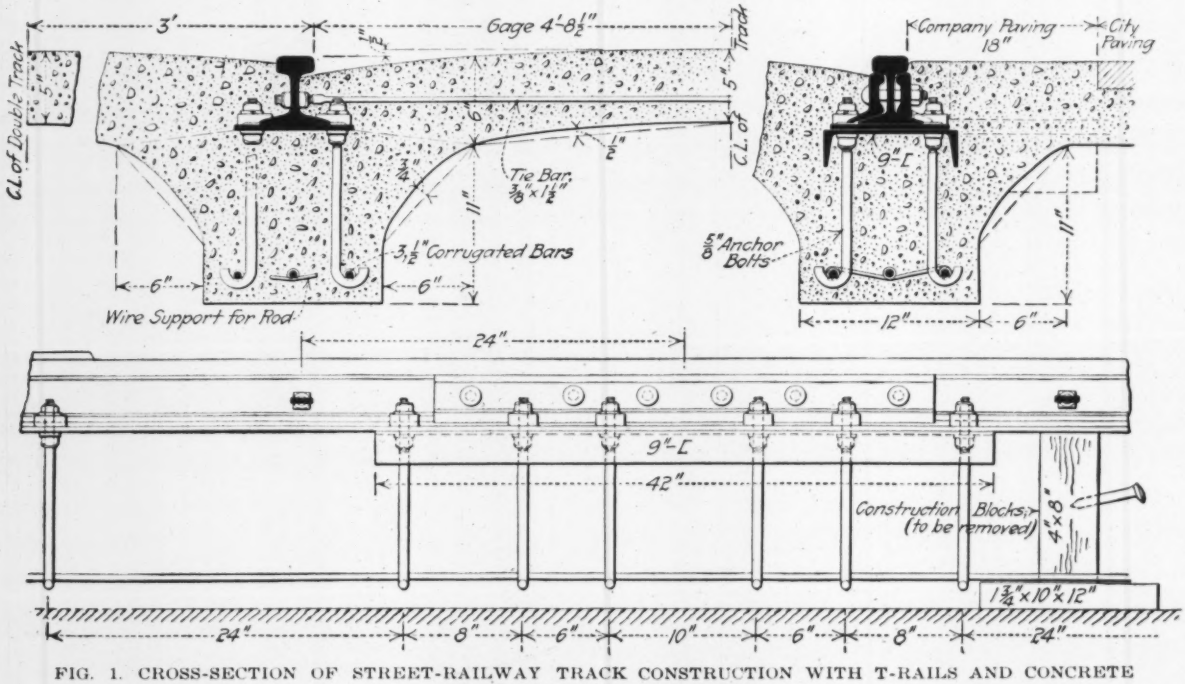


FIG. 1. CROSS-SECTION OF STREET-RAILWAY TRACK CONSTRUCTION WITH T-RAILS AND CONCRETE PAVING AT ANDERSON, N. C.

Another very common cause of failure of track pavement is impact at the joints. This may result from any or all of several causes, and when once it develops it is generally fatal to the pavement around it. We believe we can make a simple base-supporting splice which will overcome the causes of impact very largely and on the other hand will so distribute any possible impact as to render it harmless. Even patented joints in use now are dependent upon a number of factors for successful use, and all of them will fail if impact sets in.

The construction illustrated will be used immediately on about 6 mi. of track in Anderson and Greenville, S. C., and elsewhere, as may be necessary. Accurate

*Engineer, Southern Public Utilities Co., Charlotte, N. C.

cost records will be kept. It is believed that this type will be of special interest in view of the fact that whereas a few years ago paving was not required except in the centers of the larger towns, now railway companies are forced to pave tracks even in smaller towns and in all classes of streets, where falling revenues with light traffic do not justify high rails and expensive construction.

No patents have yet been granted, but an application is being prepared which will cover the principal features. We do not claim that this construction is new throughout, for we have gleaned several ideas. Many features, however, are entirely new and the arrangement as a whole is new.

Features of the Design

The special features of this type of construction may be stated as follows:

1. Use of low T-rail instead of high T-rail. With the latter rail (a) it is necessary often to buy more metal than is required to carry the traffic, in order to get paving depth; (b) the same tonnage costs about 30 per cent. more than standard rail because it is special; (c) the same tonnage gives less wear than the standard rail, because of the smaller amount of metal in the head of the high rail.

2. Continuous rolled-steel bearing plate. This plate, $\frac{3}{8}$x8 in., affords great resistance to overturning, and distributes the stress over a width much greater than that of the rail base.

3. Strong and frequent anchorage of rail to plates embedded in the concrete. This is afforded by the long hook bolts, which also serve to hold the longitudinal reinforcing rods in the bottom of the beam during construction.

4. Continuous, reinforced-concrete girder under each rail. This girder is made of strong, rich concrete and is capable of taking our heaviest cars over short spans where wide trenches have sunk, or over longer stretches of poor soil, without destroying the structure.

5. Provision for shrinkage of the concrete. This is made by the use of jam nuts and wood washers under the base plates and high-tension split washers on top of the rail clips. The top nut will be drawn down until the lock washer is flat. If there be any shrinkage, the weight of the cars will cause the plate to sink down until the wooden washer is compressed and the load bears evenly on the concrete, when the lock washer above will open slightly and prevent any lost motion.

It is hard to see how any considerable amount of shrinkage can take place under the plates. If the center of the shrinkage be assumed as at the center of the 12-in. beam, therefore 6 in. under the plate, and the shrinkage as 0.08% (a liberal allowance), theoretically the relative motion between the plate and the rail will be only 0.0096 in. or less than 1-100 in. The washer used will take up $\frac{1}{8}$ in. easily, and although we do not expect as much shrinkage as that, we can hardly believe it to be as computed, less than 1-100 in.

6. Elaborate treatment of the rail joints. The intention is to secure a perfect fit of the rail ends, so that there will be no initial pounding, and to make a structure so strong and stiff that it will not allow relative motion of the parts. The rail ends will ordinarily be finished by grinding; but in some cases where the track is laid in earth the rails have never closed the expansion joints, and the interurban cars have badly pounded the rail ends. In these cases the ends will be cut off with a power saw.

The rails will be laid close, no allowance being made for expansion, since the area of metal exposed to the sun will be small, and the concrete surrounding the rail will rapidly conduct the heat away. The holes in the rail are 1 in. in diameter. The bolts used will be $\frac{7}{8}$ in. in diameter, of Mayari heat-treated chrome steel, with a very high elastic limit. The bolts are a very important part of the structure. The object in using these large bolts in the 70-lb. rails is to get great strength as well as to fill the holes in the rails to get a continuous structure. The splice bars are of standard angle section, with notches cut in the flange for the same kind of rail clips as are used elsewhere.

7. Increase of available conductor area. This may be secured by bonding the ends of the $\frac{3}{8}$x8-in. base plates together, with occasional bonding to the rails. The rails, if well bonded, afford ample area for the current, but the bonding of the base plates would protect the structure against any electrolytic action (however unlikely). Although with good rail bonding this plate bonding would be superfluous, it would be a good investment as a protection against defective bonding if it prevented the loss of only about 1000 kw.-hr. annually per mile. We intend to experiment with this feature.

Advantages of This Construction

The advantages are nearly obvious and may be summed up under four heads:

1. Complete adaptability. The only articles not on the market as stock are the hook bolts and the wood washers. The construction is adaptable to any density or weight of traffic, conditions of soil, size of rail, etc., by modifications of beam, anchors, etc.

Where the rolling stock is exceedingly heavy and the schedules close and fast, we would use a deeper beam, properly reinforced, with larger anchor bolts and a 2x8-in. creosoted pine stringer with field notches in the sides for the anchor bolts to pass through. In such a case, we contemplate special provisions for the renewal of rails and stringers—matters which need not be entered into here. In general, we believe that a proper modification in the steel structure would be sufficient.

2. Permanence. This construction is believed to be as nearly permanent as a track structure can be built.

3. Comparatively low cost, $15,079 per mile of single track. This averages about $3000 per mile cheaper than ballasted high T-rail construction, which involves an excavation 18 in. deep, 9 ft. wide; 5-in. rolled ballast under ties and to tops of ties 2 ft. in middle of track; oak ties 6x8 in. by 8 ft., 30 in. c. to c.; 7-in. 80-lb. T-rail 60 feet

ESTIMATE OF COST PER MILE OF SINGLE TRACK (EXCLUSIVE OF BONDING) *

Excavation, 1160 cu.yd. at 50c	$580
Rails, 110 tons at $38	4,180
Splices, 9969 lb. at $2.10	209
Bolts, 1320 lb. at $0.0435	57
Lock washers, 1056 lb. at $0.01	11
Clips, 7300 lb. at $0.0235	171
Machine bolts, 3000 lb. at $0.012	36
Hook bolts, 4800 lb. at $0.035	168
Split washers, 7800 lb. at $2.65 per M	20
Base plates, 107,000 lb. at $1.68 per 100 lb	1,797
Corrugated bars*, 56,000 lb. at $1.665 per 100 lb	933
Channels, 8500 lb. at $1.68 per 100 lb	143
Tie-rods, 700 lb. at $0.16	112
Hauling steel on work car, 190 tons approximately at 50c	95
Assembling track, no tamping	500
Concrete, 1160 cu.yd., at $5.23	6,067
Total cost of materials and placing	$15,079

* Four bars in each girder, instead of three as shown by the drawing. Due to foundationd conitions.

long; concrete, 1 : 1½ : 3, from bottom of ties under rails to tops of paving.

4. Minimum maintenance and depreciation charges.

Concrete Paving and Foundation

Concrete Surface—Concrete was adopted because (a) the experience of ourselves and others has shown it to be a satisfactory wearing surface when the foundation is not broken up; (b) a concrete surface can be laid more cheaply with respect to material, and if monolithic with the base, more cheaply also with respect to labor, than almost any other suitable surface; (c) concrete is best adapted for use with low T-rail.

The wearing surface used heretofore has been a 2-in. course of cement and granite screenings mixed 1 : 1½, with screenings ranging from ⅜ in. to $\frac{1}{32}$ in. This is very satisfactory, but the screenings become expensive at times on account of the fact that no dust is allowed in them. We have not had many of the troubles supposed to be inherent in two-course pavement, but we have here adopted a coarse concrete top because it will be cheaper, and will wear as well if properly put down.

A mix of 1 : 1½ : 3 was chosen at first to make proportion of cement and sand the same as proportions of cement and screenings in our former top, and then because this mix seemed largely used elsewhere. But it is probable that we shall use 1 : 2 : 4 or even 1 : 2 : 4½ in case we get as low a percentage of voids in the stone as we expect. The sand will be, as nearly as possible, about half coarse and half fine, as this has been found to be the strongest mixture of sizes. The stone will be blue granite, from ¼ to 1 in., and we expect to get a low percentage of voids.

Method of Rolling the Concrete Surface

We expect to use hydrated lime to the extent of about 8% of cement used (proportioned by weight) to secure density and waterproofness. We plan to roll with a small cast hand-roller of sufficient weight, rather than to tamp; then to wood-float it, trowel it and score it into blocks 5x10 in. with staggered joints. We have two alternate treatments of the surface in mind; one is to scatter on the concrete a light course of screenings, trowel and score as before; the other is to scatter on the top a course of 2-in. stone after tamping or rolling with a gridiron surface, the stone being lightly rolled so as to bring flat faces up and make them flush with the mortar.

If the roller is made with blades 1¼ in. deep, 1 in. apart, it is believed that only ½- and ¼-in. stone will remain on top, with an excess of mortar in which the 2-in. stone will be bedded. This will be rolled with a plain roller to bring the flat sides up, and together with the small stone form a good wearing surface. These alternative methods will be tried, and perhaps adopted if found better than the plain concrete. Of course if 2-in. stone is put on the surface it cannot be blocked off.

Paving Base—This will be the same mix as the top, will be monolithic with it and also with the track foundation.

Track Foundation—This will consist of large reinforced-concrete girders under the rails, of the same mix as the top and paving base, reinforced with three or more corrugated bars lapped so as to be continuous.

Cross-Section—The track foundation and pavement, which are monolithic, take the form of an arch, the pavement in the middle of the track forming the flat crown and the girders under the rails forming the abutments. It was desired to make the entire structure effective; the girders, carrying the track loads, and the crown, upon which there is street traffic only, being proportioned for those loads.

The shape of the surface, which is crowned from beneath the rail heads and has no distinct groove, has been our standard for several years, both with concrete and brick pavements. It has been satisfactory both to us and to the citizens.

At 50-ft. intervals will be expansion joints not over ½ in. wide, 5 in. deep, filled with asphalt and stone dust. Midway between these will be contraction joints made by using a thin steel plate (greased), which is removed after the concrete has set. The joints are filled by pouring in hot asphalt.

Design of the Track Structure

Rail—We use the Am. S. C. E. 70-lb. T-rail section because it gives maximum wear on account of the center bearing and distribution of the metal; and further because it is the cheapest rail since it is a standard section and rolled by all mills.

Bearing Plate—A width of 8 in. was selected as about the maximum which might be used without isolating a cake of concrete above it; and because this width afforded about the right projection from the rail base for the bolts and clips. The thickness of the plate is greater than that found by static computations, but not too great when the shocks of our heaviest cars are considered.

Anchorage—It is contrary to facts to assume that the rail will lie flat on the girder, and therefore anchors spaced from 5 to 10 ft. apart are insufficient. The rail should have a uniform bearing and should be held uniformly on that bearing. This calls for anchors much closer together than is customary in this class of construction. We have generally anchored the rail every 2 ft., and closer at joints.

Tie Rods—We have adopted a ⅜x1½-in. flat tie rod, but have placed it only 1½ in. from the base of the rail, so as to have it as low in the paving as possible, to prevent cracking. Should cracking develop, we will use a strip of light wire mesh over the rods. We have held to tie rods, although with similar construction (Rinehardt system) in Berlin and elsewhere they have been found unnecessary.

Rail-Joint Reinforcing—Impact is responsible for the failure of joints in paved streets. It may be developed from the first because of uneven surfaces of the rail heads, or it may be developed later by pounding in consequence of broken wave motion. Where the support is yielding, there will be a concavity under the wheel, and where the anchorage of the rail is not frequent and powerful, there will be a convexity ahead of the wheel. The conditions necessary for transmission of wave motion (and load, of course) are that the splice bars shall be long enough, strong enough, not worn badly and tight-fitting. The wear usually takes place on the top of the bars.

The conditions favorable to failure resulting from improper fit of the bars are: Bolts overstrained when first put on; poor mechanical fit; movements of the rails because of expansion and contraction (allowed by the long holes in bars and large round holes in the rail); and badly worn condition of bars.

We will guard against overstraining the bolts by using large heat-treated steel bolts with strong washers; but we must depend upon the manufacturers for good initial fit. We will provide against temperature movements by having bolts fitting the holes in the rail tightly and butting the rail ends close together. We wished also to have the holes in half the bars made round, so that by putting all the nuts on one side of the rail we could have close-fitting bolts in the splices also; but the bars were punched before we decided on this. We do not know how better to prevent wear of the tops of the bars than to use higher carbon metal; this wear is a combination of compression of fibers and flow of metal. We planned to use the splice bars without the nearly horizontal leg, but the cost of rolling or of shearing after rolling was prohibitive.

We have met the requirements for an efficient joint as follows: (1) Rail heads will be ground, and in rails already battered the ends will be sawed off. (2) Looseness will be prevented by the use of closed joints, large high-tension tight-fitting splice bolts and strong anchorage of the track by means of anchor bolts. (3) A steel channel

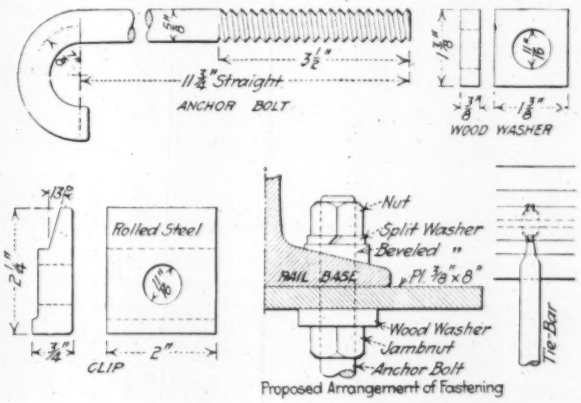


FIG. 2. DETAILS OF T-RAIL TRACK FOR STREET RAILWAY AT ANDERSON, N. C.

is provided to transmit flexure, this being anchored to the rail and plate over a considerable length so as to maintain the rail ends in the same plane. (4) The base plate and channel will distribute load and impact.

Reinforced-Concrete Track Girders

The ultimate support of the wheel loads is the earth, the bearing value of which is limited, variable and uncertain. Therefore pressure should be distributed over as large an area as possible. Under any circumstances there will be some deflection and some settlement. The former should be as small as possible and the latter should be even, so as not to disturb the pavement. Both these considerations point to the necessity for having beneath the rail a member capable of taking the entire wheel load and distributing it over the requisite area of earth. For this purpose we have adopted the reinforced-concrete girders.

There are two general methods which may be used in the design of the girder: One is to assume that the rail and the reinforcing rods form the chords of a built-up beam, and that the concrete and anchors transmit the shear only, the rail taking the compression instead of the concrete. This assumption involves another—namely, that the longitudinal shear will be transmitted from rail to plate, and thence to concrete, and there will be no slipping there. In order to be sure of securing this condition, it would be necessary to have bolts through the rail base (as shown in Fig. 2). With this construction a low T-rail can be used under all traffic, the minimum requirement being to use enough reinforcement to throw the neutral axis at or near the base of the rail, so that there will be no cracking of the concrete. The depth and reinforcement will vary with the loads.

The other method of design is to assume the load on the concrete beam as practically concentrated, and to place sufficient reinforcing in the bottom of the beam to distribute it over an ample area of earth.

Of the two schemes, the first is perhaps the better from a cost standpoint, generally speaking. But in our case we are using rails already on hand, and will use them with clips and reinforce for almost the entire load (with shock) concentrated. We believe that when rails are ordered from the mills, the cost of punching holes in the base of rail plus the cost of beveled washers would be less than the cost of the clips used on the edge of the rail, and the reinforcing would be more efficient and cheaper. We have just ordered a hydraulic punch, which should enable us to punch holes in the field rather cheaply, and we will see what can be done in this way. The base plates under the rails are counted on only to widen the bearing area on the concrete.

Answers to Criticisms of the Design

The criticisms which have been made of the above system of track construction may be considered as follows:

1. The track will be too rigid. We believe a really rigid track can be built and be successful, the vibration being taken up in the cars. We know of tracks in this country and abroad which are similar to this and give no trouble due to rigidity.

2. Concrete is not suitable for a wearing surface. Our whole experience has been a contradiction of this, even though some of our own work is not satisfactory.

3. The expansion joints in the concrete will spall and disintegrate. We have never had trouble from our expansion joints. We originally used for edge protection a set of plates, which were anchored into the concrete by bolts; but this was very troublesome and somewhat expensive, so we have since been using the joint described in the specifications. The most important things about expansion joints are to get them narrow and to thoroughly compact the sides with an edger.

We also use an edger against forms for the edge of our pavement next to the city pavement, and have no trouble here either; although we formerly had this edge sloping outward upon the theory that that would prevent spalling, the most noticeable effect of this slope was to allow the asphalt to crawl up it under the ironing effect of vehicular traffic, ultimately causing a rut there, so we have since made the edge vertical. The contraction joint we have adopted because we have found that where the expansion sections were laid 50 ft. apart a contraction crack nearly always formed exactly midway.

4. Underdrainage. We have no provision for underdrainage and do not believe it necessary in our conditions.

5. Electrolysis. The possibility of electrolytic action upon the steel below the rail is very remote, and may be obviated at little cost.

6. Regaging or changing rail or grades. When the rail needs regaging or renewing probably we will wish to

double-track the line. The grades are set by the city, and there is only the remotest possibility of having to change them. Provision could be made for regaging or renewing rail by using long holes in the plates (for adjustment), by separating the foundations and top slab by a layer of heavy paper, and by tipping the tops of the anchor bolts with tar, so that they would not rust.

7. Shattering of concrete. It has been suggested that the concrete around the rail may be shattered by vibration or by ice under the rail and plate. The vibration of the rail will be so limited with anchorages 2 ft. apart that it will be incapable of causing impact. Little or no water can find its way under the rail, but in a colder climate tar or asphalt might be poured along the edge of the rail.

8. Special work and curves. Our special work will be laid on steel or wood ties on a concrete base. For curves, the plates will bend the same as the rail. Steel-weld compromise rails will be used instead of compromise joints.

Construction Methods

The water is taken from hydrants along the curb, and no charge made against the contractor for it, as the company owns the water-works system.

The cement is furnished by the company in warehouse or in cars in railway yards, and is hauled to the job by the contractor and protected by him. As the inspector on the job receipts for the cement delivered on the job and shows on his report the disposal of it, we know just what mixture we are getting. By thorough experiment we will find the length of track which should be built with a certain amount of cement, so that we will have both a check on the grading and on the use of the cement.

The stone is delivered by the company on the streets to be paved, at the intersections. We have several cars built for this purpose having an A-shaped bottom and slide doors which trip by a hand lever operated from the cab. The load can be dumped in six parts, as the length of the car is divided into three compartments, and each compartment dumps half on either side. The load dumps well clear of the rails.

The rails are in general those at present in service; and they are removed by the combined forces of the company and the contractor. This is done by jacking up the rails every 15 ft. and knocking off the old ties with sledges. The specifications state that we will take up the rail and the contractor will take up the ties. Contractors generally are loath to participate in this method, as they seem to feel that advantage is being taken of them, although it is more to their advantage than to ours.

The excavation is done mostly by pick and shovel, and the hauling by wagons. Tamping is used, as rolling is not practicable here. When the excavation is ready the company assembles the track and puts it to line and grade. No attempt is made to have the track to final line and grade for more than a block ahead of the concrete, as temperature changes and other disturbances would destroy it. Of course, the track will be fixed longitudinally, as one end will be completed and fast. The track is supported vertically during construction by bearing blocks under the anchor bolts (which are rigid on account of the jam nut under the bearing plate). The track is lined by staking from the sides.

The concreting was intended originally to be done entirely from set-ups at the intersections, using plank runways in center of the track and 6-ft. hand carts for hauling the concrete. The placing of the concrete was to begin at the middle of the block, and back up toward the mixer as the work proceeded, the carts returning on the roadway beside the track. It was believed that these carts would be very economical for this work. It was afterward decided to spout the concrete into place, which was done with very good results. A 2½-in. top surface is made with concrete 1 : 1¾ : 3½, using ⅛- to ⅝-in. stone, which gives a surface that can be finished as smooth as a sidewalk. This is quite satisfactory, and although the concrete is put on in two courses it forms in effect one solid mass.

The concrete is placed and finished as specified elsewhere. The scoring board used to block off the surface is made of heavy timbers, having a crown slightly flatter than the finished pavement. This crown is sawed out of the thickness of the timbers. On the bottom or working side there are V-shaped oak strips put on in a staggered arrangement to follow the lines of 5x10-in. joint blocks. This board has a length equal to the width between rails and a width of 20 in. or four courses of blocks.

The strip is left off from the last block edge on the front side and when the board is moved forward the last strip on the rear side is set across the ends of the short joints of the last course scored. This is done because it was found that when the outer edge of the last course was printed, and the men attempted to set the board for the next width, they lost time getting the oak strips to register in the last one of the last width, and often made a double joint there, whereas when the short joints of that course only are printed before taking up the board, the rear strip can be set across their ends at the next setting without trouble.

These boards have scored over 100,000 sq.yd. of paving for us and have been perfectly satisfactory. They cost about $5 each, will print about 10,000 sq.yd. (with frequently renewed oak strips), and would last indefinitely except that the men in using them tamp on them with a pick or other heavy object. Two or three light blows suffice. They are operated by the finisher and water-boy or one of the common laborers, and this scoring really adds practically nothing to finishing cost, because it goes very rapidly and the finisher has ample time from his floating to do it.

Separate boards with no crown can be used for the flat paving outside the tracks, and this method is better than having that part done by a long single board. We have used for the space between double tracks a longer board similar to the one used in the tracks, but with the end bearings arranged to allow the printing to be done ¼ in. below the rail instead of 1¼ in. These boards are kept greased. They have handles made of old rubber hose.

Specifications for Construction Work

The specifications include the following sections governing the construction work:

Outline of Work—(a) The company will remove the old rail. (b) The contractor will remove the old ties to the edge of the street; they are not to be sold. (c) The contractor will excavate to cross-section shown on plan and to grade set by the city engineer or the engineer of the company, and will tamp the subgrade to the satisfaction of the engineer. (d) The company will build track ready for the concreting. (e) The contractor will place concrete and protect it until acceptance.

Excavation—Earth must not be disturbed below subgrade. Where filling is necessary it shall be done with approved material in 5-in. layers and thoroughly tamped. Waste excavated material shall be the property of the company, to be

hauled by the contractor to any point designated, not over 2000 ft. on good roads.

Concrete—To be composed of 1 part cement, 2 parts sand or screenings and 4 parts crushed stone (size passing 1-in. ring and retained on ¼-in. ring), and hydrated lime 5% of weight of cement. To be laid of a consistency satisfactory to the engineer, thoroughly tamped and floated with wooden float, troweled if required, and blocked off if required by the city. The scoring to be shallow grooves made with a scoring board.

Joints in Paving—Contraction joints to be provided every 50 ft., to be not over ½ in. wide, 5 in. deep, filled with asphalt and stone dust. These are to be made by using weather-boarding, dressed on both sides and greased, and withdrawing the board after concrete sets and filling as noted before. Midway between these joints shall be contraction joints made by using a thin steel plate (greased) withdrawing after concrete sets, and pouring with asphalt. Both these joints must be thoroughly compacted along their edges by using edgers of small radius.

Protection of Work—In hot weather the pavement shall be kept wet for at least three days (sometimes longer) by the liberal use of water sprinkled upon it. The company furnishes the water. When required by the engineer 3 in. of sand shall be sprinkled upon the pavement for the purpose of holding the moisture, and keeping the pavement cool. In cold weather, if the thermometer is below 40° at 4:30 p.m., and is going down, all placing of concrete must be stopped and that part which is already laid must be finished as soon as possible. If the thermometer is going up at 4:30 p.m., work may be continued until 6 p.m. When required by the engineer the work must be covered with tar-paper and 2 in. of horse manure. Other means may be used if preferred by the contractor.

Car-Transfer Ferry on the Ohio; C., B. & Q. R.R.

In order to develop a new rail route from the Northwestern States to the Gulf, the Chicago, Burlington & Quincy R.R. is building a line 13 mi. in length from its present terminal at Metropolis, Ill., to connect with the Nashville, Chattanooga & St. Louis Ry. at Paducah, Ky. The principal engineering feature of this line will be the great double-track bridge across the Ohio River, but this will not be completed for some time.

To provide immediate communication across the river, the new railway has been extended down the bank on each side of the river, and cars will be ferried across on transfer boats. These are double-track deck scows, accommodating ten freight cars on each track. They will be handled by tow-boats. The distance between landings is about one mile.

At each landing an incline is laid to about low-water line, and on this rides a cradle, which is moved up or down the incline to keep its rails at the same height above the varying level of the water. The cradle is shifted as required by a cable attached to a locomotive and passed around a hitching pulley on the cradle frame. The incline has a descending grade of 3 per cent. for a length of about 2000 ft. The track on the cradle is level, with a short 4 per cent. grade rising from the incline track to the cradle track.

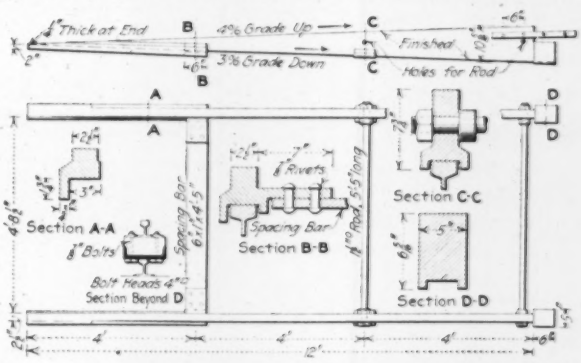


FIG. 2. FEATHER-RAIL CONNECTION BETWEEN TRACK ON INCLINE AND TRACK ON CRADLE

The incline is double-track, with two cradles, one for each track on the boat, but the cradles are separate and are operated independently. The river end of the incline is a double-track timber trestle, with five-pile bents 13 ft. c. to c. under each track and two lines of 8x16-in. stringers under each end of the 10-ft. ties. Fender timbers are laid upon the outer ends of the caps. The tracks are 12 ft. c. to c.

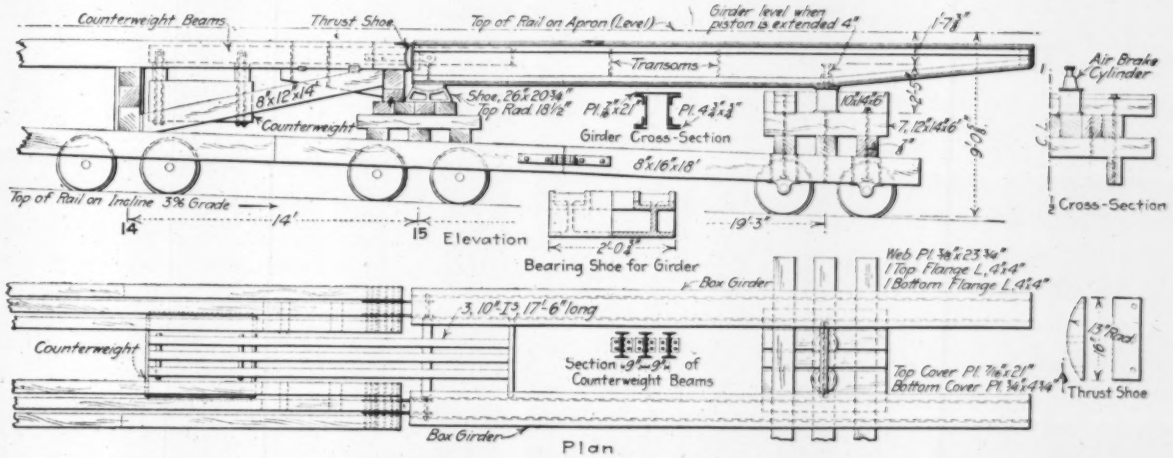
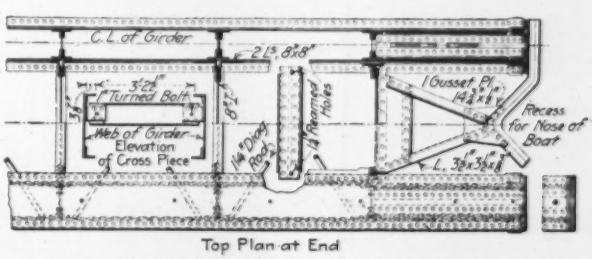


FIG. 1. ADJUSTABLE APRON CONNECTION BETWEEN CRADLE AND CAR-TRANSFER BOAT



The general construction of the cradle is shown in Fig. 3. It is 240 ft. long. Its deck consists of two pairs

of 8x16-in. stringers upon which are laid the 10-ft. ties. At the land end, where the height is low, the stringers rest directly upon axles arranged in pairs. As the height above the incline increases they are supported by blocking or cross-timbers on two lines of substringers, which are mounted on the axles, as shown. The wheels are mainly 33-in. car wheels. As the joints of the stringers are in tension when the cradle is hauled up the incline, they are spliced by horizontal bolts passed through the outstanding flanges of L-shaped straps spiked to the sides of the timbers. These connections also give vertical flexibility to allow for irregularities in track surface.

Land and River Connections of Cradle

At the land end of the cradle is a pair of 12-ft. feather rails to connect the track on the incline with that on the cradle. This connection is shown in Fig. 2. The feather rails are steel castings 12 ft. long, grooved on the under side to ride on the incline rail, while the upper surface forms a running head for the wheels. At the toe, where the wheels are engaged, the thickness of the feather rail is only ¼ in. At the heel there is a splice connection to the track rail on the cradle.

The river end of the upper deck of the cradle is an adjustable apron 30 ft. long, supported by cross-timbers on the substringers. This is shown in Fig. 1. It consists of a pair of heavy box-girders, connected by crosspieces and diagonal lateral rods. The I-beam crosspieces are not connected rigidly to the girder webs, but are secured by horizontal pins through angle brackets on the webs. This allows for variations in level of the opposite rails of the incline track, the girders being free to rise and fall independently in a vertical plane, while with rigid riveted connections severe twisting stresses would be set up.

The apron is supported at the heel and one intermediate point, and its outer end is cantilevered beyond the latter. The outer end is raised and lowered as required to compensate for slight changes in level of the tracks on the cradle and the boat and to bring these rails into exact position. For this purpose its outer support carries a pair of air-brake cylinders, with piping led along the cradle and fitted with hose so that it can be connected to the brake system of the engine handling the train. To balance the apron it is fitted with an extension arm consisting of three 10-in. I-beams having a counterweight box suspended from their ends.

Vertical and lateral movements of the apron are provided for by a hemispherical bearing under the heel of each girder, and a similar bearing or thrust shoe at its end, butting against the end frame of the cradle. The outer end of the apron is heavily built and braced to withstand blows and has a recessed end frame to receive the V-shaped nose on the end of the boat, thus automatically centering the tracks. Portable rail stops which slide on the rails are used to hold the cradle in position on the incline track, and also to hold the train on the cradle while making the rail-end adjustments of apron to boat.

The new railway is being built under the name of the Paducah & Illinois R.R. The incline on the Illinois side of the river was built and is owned by the Chicago, Burlington & Quincy, and that on the Kentucky side by the Nashville, Chattanooga & St. Louis, of which Hunter McDonald is Chief Engineer. The Chief Engineer of the Paducah & Illinois is C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy.

Federal and State Co-operation in Water-Power Control

By Leonard Lundgren*

Much has been said and written along theoretical lines about the dual control of water powers in the United States by the Federal Government and the Sovereign States, control by the former arising from the ownership of public lands and by the latter from state laws on the appropriation of water. Many writers have attempted to

*District Engineer, United States Forest Service, Beck Building, Portland, Ore.

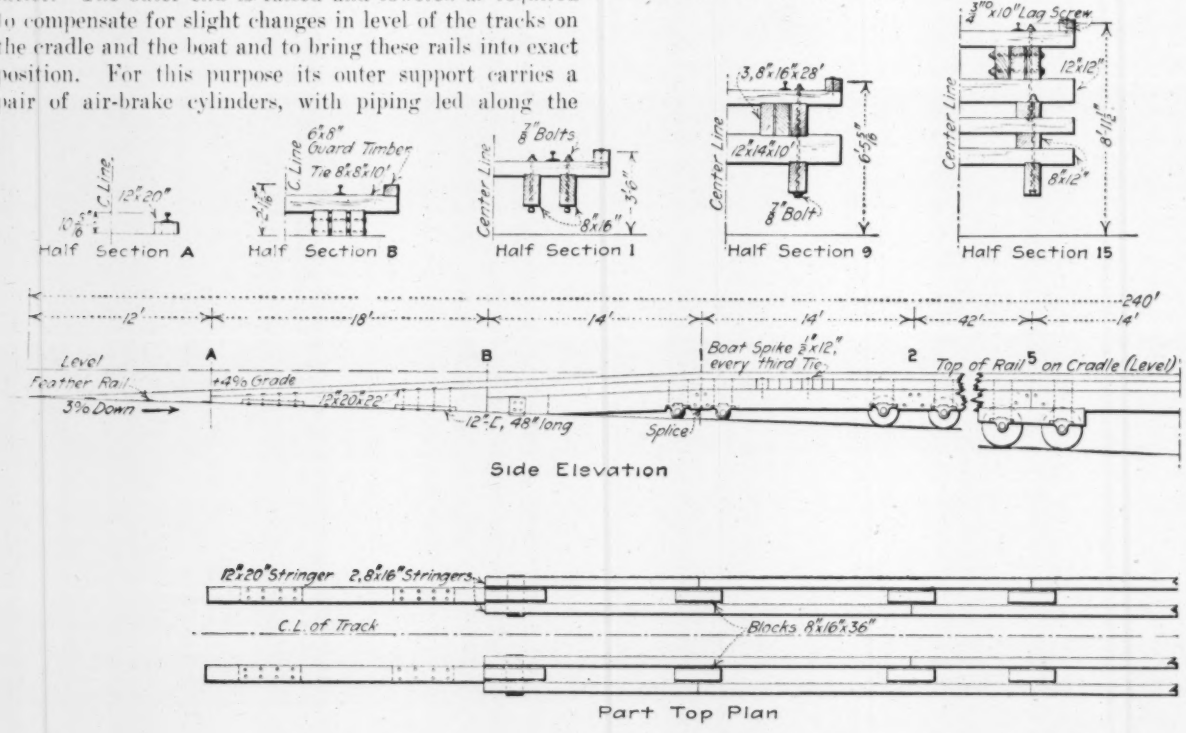


FIG. 3. CRADLE ON INCLINE OF CAR-TRANSFER FERRY ON

point out that such dual control is incompatible with the industrial development of the country and actually hinders its growth. In practice, however, the Federal Government works in the closest harmony with the State. The regulations of the Secretary of Agriculture, effective Feb. 1, 1915, contain the following:

> Wherever the approval of a state administrative official, board or commission is a condition precedent to the right either to take and use water for power purposes or to engage in the business of the generation, transmission or distribution of power, certified evidence of such approval must be filed . . . before a final permit will be issued. Formal notification by such official, board or commission that the water right has been canceled or that the permission to engage in the power business withdrawn, will be deemed sufficient grounds for the revocation of the permit.

These or similar requirements have been in force in the regulations of the Departments of the Interior and of Agriculture for the last five years. During this period no person has secured a permit to construct a water-power plant on public lands without first securing a water right from the state.

Coöperation with State of California

A year ago, in order to facilitate the approval of applications for water power both by the state and by the Federal Government, a coöperative agreement was made between the Secretary of Agriculture, Hon. G. F. Houston, and the State Water Commission of California, of which Prof. Charles D. Marx, President of the American Society of Civil Engineers, is Chairman.

This agreement provides that whenever an application for a permit for a water-power site is filed with the District Forester of San Francisco, notice of the application will be sent to the State Water Commission. Whenever an application is made to the State Water Commission for a permit to appropriate water, if the use of such water will in any way make necessary the occupancy of any national forest land, the State Water Commission will give immediate notice to the District Forester at San Francisco. Further clauses of the agreement provide in substance that neither the State Water Commission nor the representatives of the Federal Forest Department will issue permits to water users until both authorities have given final approval to the application.

In accordance with this agreement the Secretary of Agriculture a few months ago refused certain rights-of-way in the Inyo National Forest to a company, as its previous application for the privilege of using the water of certain creeks had been rejected by the State Water-Supply Commission on the ground that the public interest so demanded. The company argued against this decision on the ground that the streams proposed to be appropriated were located entirely within the National Forest reserves and that the state authorities, therefore, had no voice in the matter. The Secretary of Agriculture in refusing to reconsider his decision said:

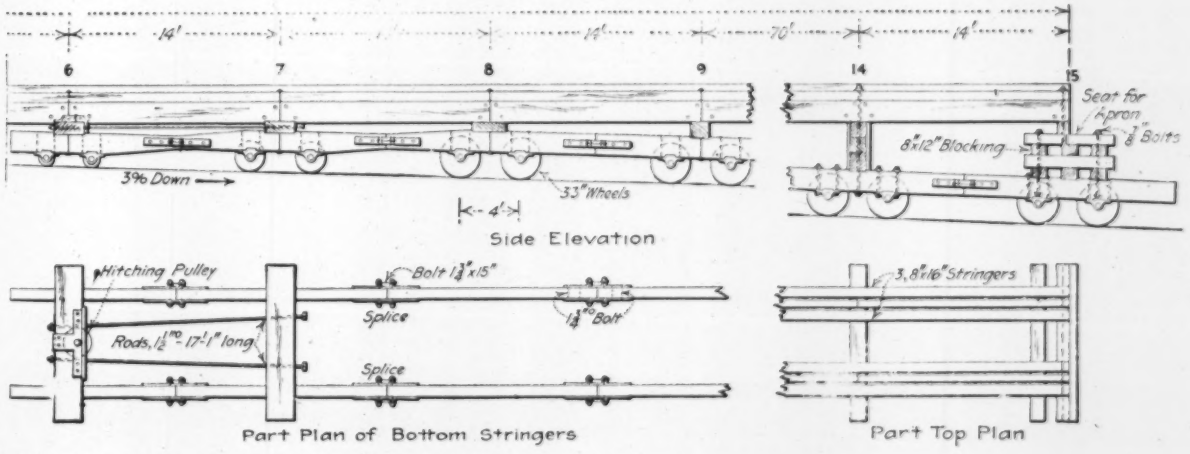
> It is believed that better results can be secured under existing conditions by coöperative action between the state and Federal authorities than by any insistence upon strict legal rights on behalf of either.

Another coöperative agreement has been made between the Department of Agriculture and the State of Oregon, represented by the State Engineer. This is framed on lines similar to those of the agreement with the State of California and provides that the District Forester at Portland and the State Engineer will each furnish the other with data and coöperate while acting upon applications for power permits on National Forest lands. This agreement was consummated in May, 1915.

It is anticipated that other states having laws which permit coöperation as outlined above will see the advantages that accrue and will accordingly enter into similar agreements.

⁂

Lump-Sum Allowances for Extra Work were recently the subject of a dispute among the public authorities of New York City. Contracts let by the Public Service Commission for subway or other rapid-transit work require to be consented to by the Board of Estimate, which makes the appropriation to pay for the contract. Recently when several contracts awarded by the commission came before the board for appropriations, the board made the appropriation conditional on the elimination of a clause in the contract authorizing the chief engineer of the commission to fix either unit prices or a lump sum for incidental or extra work as it arose. The prior arrangement for extra work had been cost plus 10 per cent. This arrangement led to excessive supervision and accounting, which is avoided by using the lump-sum or the unit-price method of payment. For some time past the commission's contracts have included a clause making the latter methods optional as alternatives to the percentage method, and the board has hitherto approved such contracts. The board's conditional appropriation formed the subject of a court action by the bidder to whom a contract had been awarded for mandamus to require the board to give its consent and make the appropriation without qualification. The mandamus was issued by the court, and the board then consented to the contract and made the appropriation without condition. No appeal to a higher court was taken, because the board did not want to delay subway construction work; but it has made the statement that it does not accept the view taken by the judge who issued the mandamus and will carry the matter before a higher court on a subsequent occasion.



THE OHIO RIVER: CHICAGO, BURLINGTON & QUINCY R.R.

Field and Office

Lap-Bolted Crossbracing in Wide and Deep Cut

Bolted continuous crossbracing of subway excavation is employed by the Cranford Co. on sections 1 and 1A of the Flatbush Ave. subway, in Brooklyn, New York City. Each crossbrace is built up of 6x12's, 16 ft. long, lapped 8 ft. and bolted together, forming a continuous 12x12. The bolt holes are located by templet, so that they will coincide, no matter which ends are lapped. This means rapid timbering and avoidance of waste. The crossbraces are posted and spread as shown in Fig. 2.

The illustrations show the timbering at Prospect Park Plaza, where the excavation reaches a maximum width of 100 ft. and a greatest depth of 82 ft., providing room for diverging subway tracks on three double-track levels. In the upper part the bents are spaced 10 ft., in the lower part 5 ft. c. to c. The bents of the lower portion of this cut are not in the same vertical plane as the upper bents because of interference of steelwork; longitudinal timbers of the same lapped construction as the cross-struts are used at the top of the offsetting to bridge. Elsewhere on the line the bent spacing is 10 ft.

John C. Sheridan, Chief Engineer for the contractor, devised the bolted timbering.

FIG. 1. GENERAL VIEW OF TOP OF DEEP OPEN CUT AT PROSPECT PARK PLAZA, BROOKLYN

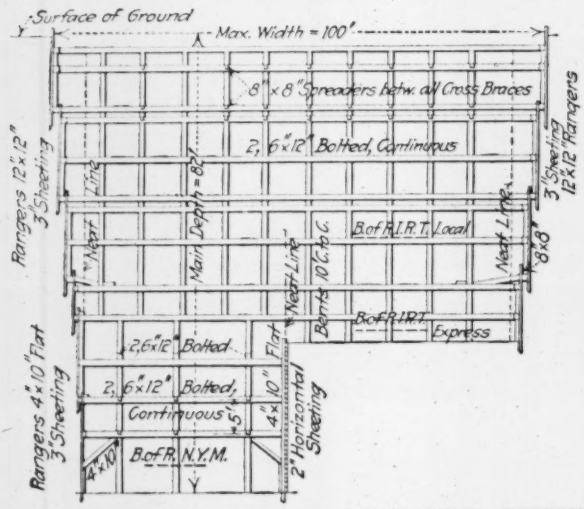


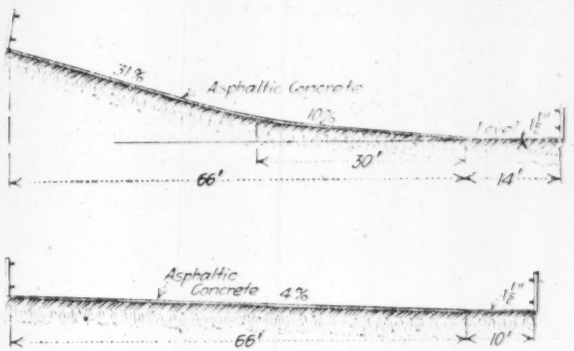
FIG. 2. SHERIDAN'S SCHEME OF TIMBERING; BOTTOM OF 80-FT. CUT

FIG. 3. TIMBERING FOR THE DEEP OPEN CUT

Adapting an Old Racetrack to Automobile Racing

A one-time famous horse-racing track at Narragansett Park, Cranston, near Providence, R. I., has recently been converted into an automobile racetrack by banking the curves and covering the trackway with an asphaltic-concrete pavement. The track is owned by Frederick E. Perkins, President of the Narragansett Park Speedway, Inc., who has personally planned and supervised all the construction work—with no little pride that he has done so without the assistance of an engineer.

The old horse-racing track was the usual one-mile oval consisting of two quarter-mile straightaways and two quarter-mile half-circle arcs of 420 ft. radius. The track surface was hard-packed loam overlying gravel, which is only one or two feet below surface over the whole meadow containing the track. This gives good natural subdrainage, so that the only additional provision for drainage considered necessary was the sinking of shallow pits, or sumps, at intervals around the inner edge of the



FIGS. 1 AND 2. CROSS-SECTIONS OF RACETRACK ON CURVE AND ON TANGENT

track. These are lined with dry stone walls and drain into the subsoil gravel. They are covered with substantial timbers.

The surface of the old track was thoroughly rolled with a 10-ton steam roller. On the curves the roadbed had previously been banked to a maximum of about 10 ft., the earth being placed in thin layers and allowed to settle for two or three years before the pavement was constructed. On top of the compacted surface of the old track a 1½-in. asphaltic-concrete pavement was laid in two courses, the bottom course of 1 in. being mixed to conform approximately to the well known Topeka specifications, while the top course is practically a sheet-

FIG. 3. NARRAGANSETT ASPHALT MOTOR RACETRACK

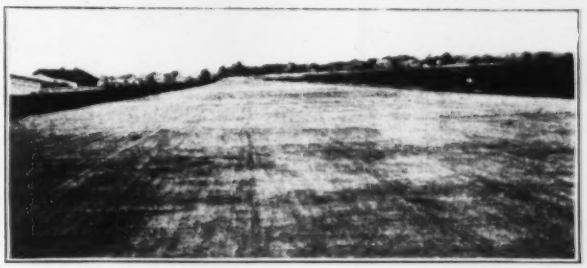


FIG. 4. TANGENT ON MOTOR RACETRACK

asphalt mixture. The pavement is 66 ft. wide, not including the 10-ft. to 14-ft. apron inside the racing line; the total paved width thus is 76 to 80 ft.

The alignment of the old track was not materially changed. The measured one-mile racing line is from 10 (on tangents) to 14 ft. (center of curve) inside the inner edge of the pavement aprons. There are no easement curves between the tangents and the curves, as this would have required a redesign of the old track. An approximate cross-section of the curves is shown in Fig. 1. To attain the maximum superelevation of about 10 ft., the P.C. of the curve of the outside edge of

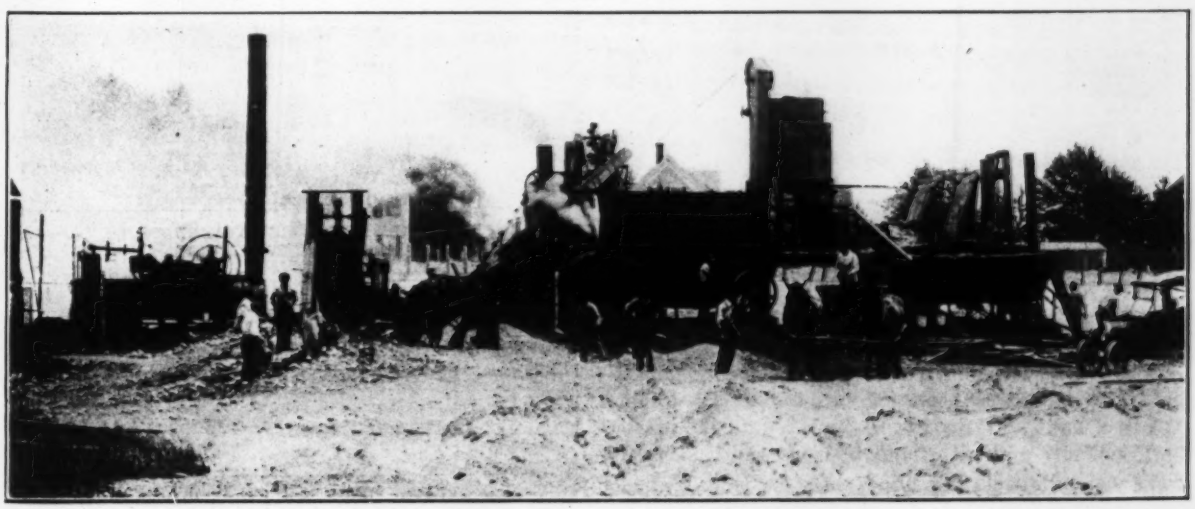


FIG. 5. CONSTRUCTION PLANT, NARRAGANSETT PARK AUTOMOBILE RACETRACK, CRANSTON, R. I.

FIG. 6. ROLLING ACROSS THE TRACK ON A 31% GRADE WITH SPECIAL STEAM ROLLERS

the track is placed at half the full superelevation, which is attained at a point 100 ft. beyond the P.C. From the P.C. to the level of the straightaway 150 ft. intervenes. Fig. 2 is a cross-section on the straightaway. The dished surface on the curves was obtained by eye, no templets being used.

For use in building the pavement, Mr. Perkins purchased one of the largest-size Cummer portable asphalt plants, a 10-ton 3-wheel steam roller, two 6½-ton tandem steam rollers, crushers, screens and bins and all other necessary paving equipment. He hired his own employees and personally superintended the work. Local stone and gravel were largely used, although imported sand and traprock were used to some extent. Work was begun in April and the pavement was completed in July at an approximate cost of $200,000. The tandem rollers had to be especially designed and built (Buffalo Steam Roller Co.) to permit their rolling the track banking, the upper half of which is on about a 31 per cent. grade. The difference between these rollers and the standard Buffalo-Pitts tandem rollers is said to be not only in the gear ratios, but in the boiler, which is designed for a higher pressure than standard.

Both edges of the track are lined with substantial posts spaced 3 ft. c. to c., to which are spiked two rows of 25-lb. steel railway rails. This railing is intended to be strong enough to deflect a runaway car back upon the track.

Inspection and Maintenance of Highway Bridges

In 1912 the state legislature of Rhode Island passed a law which put all bridges and culverts on roads which had in any way been improved by the state in the hands of the state highway department for maintenance and repair. In this way the perpetual care of about 156 bridges of various types was suddenly thrust upon a small engineering staff already with plenty of work to do. The bridges had been built at various times by the different county, town and city authorities and in many cases no record plans were available for filing with the state highway department.

To become better acquainted with the details of their legacy the following scheme was devised by the highway department engineers. Each bridge was inspected and measured by an engineer, and notes were made under the following heads: Name, location, type, causeway, substructure; abutments, piers, piling, wing walls, superstructure; trusses, lateral systems, bearing on abutments, floor-beams, stringers, roadway, sidewalks, railing, paint; general remarks; recommendations; notes. Two photographs, side and end elevations, were taken of each bridge with a 3A Kodak. All this was accomplished by one man in about 30 days.

From the inspection report, index cards 4x6 in. (Fig. 1) were compiled giving all the essential descriptive data on each bridge. In the filing number the first letter of the name of the county in which the bridge is located is used, together with the numerals of a serial number which runs from 1 to 156 for the entire state. A road map with the numbers of the bridges lettered on at the bridge site furnishes a ready means of locating any bridge. With the first a second 4x6 card is kept, carrying a record of the

B-11

HAMILTON AVE. BRIDGE

Location ..... Wickford (Boston Neck Road)
Type ..... Pratt Steel Truss—pin-connected
No. of Spans 1
Date Built ..... Built by ..... Town
Overall Length ..... 104 ft. Width .... 33 ft. T. W. ... 20 ft.
Clear Span ..... 101 ft. Causeways .....
Headroom ..... 24 ft. Headwalls .....
Bridges ..... Fieldbook No. 213 Plans P11
Reports and Data
Road F. B. No. 417 Sta. 950 N. K. 1908, Sec. 1
Plans

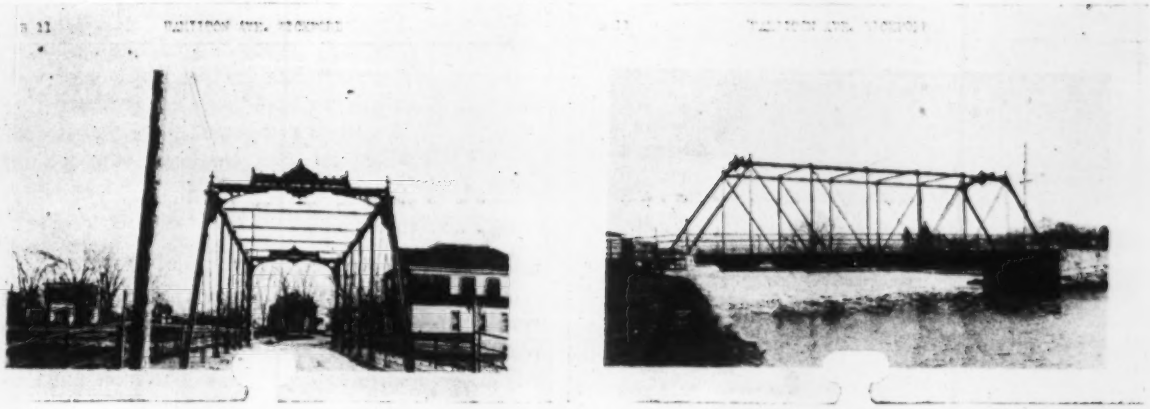
FIG. 1. RECORD CARD OF BRIDGE DATA; RHODE ISLAND STATE HIGHWAY DEPARTMENT

B-11

HAMILTON AVE. BRIDGE—MAINTENANCE

1912 Lumber and repairs	$126.95	
Painting	273.74	$400.69
1914 General repairs to sidewalk	11.82	$412.51

FIG. 2. RECORD CARD OF BRIDGE MAINTENANCE; RHODE ISLAND STATE HIGHWAY DEPARTMENT



FIGS. 3 AND 4. PHOTOGRAPHIC RECORD OF STATE HIGHWAY BRIDGES, RHODE ISLAND

repairs to each bridge (Fig. 2). The two 3¼x5½-in. photographs are mounted on 4x6-in. index cards (Figs. 4 and 5) and filed with the cards shown in Figs. 1 and 2.

As fast as they can be prepared, record plans of all the bridges are made from the field measurements. However, it is stated that the index cards and photographs afford a quick acquaintance with all the essential details of each bridge and its surroundings and have greatly facilitated the scheme for maintenance and repairs.

When repairs are made the foreman or assistant engineer in charge fills out weekly reports, 8½x11 in., which give the cost of labor and materials (differentiated). These are filed in the highway department office in a loose-leaf binder, under the bridge number, and the annual summaries only are transferred to the index card. In the same binder are kept the originals of the inspection reports.

Besides the file of cards of bridge descriptions and repairs, which are arranged consecutively by number, a separate card file is kept, arranged by names of towns alphabetically, under the name of each town being a list of the bridges in the town and their numbers. Another card file is kept of the bridge material on hand at different points.

The Chief Engineer of the Rhode Island State Board of Public Roads is Irving W. Patterson and the Assistant Engineer in charge of bridge inspection is J. V. Keily.

Organization for Bridge Work by Day Labor, St. Louis

The adoption of the day-labor system for the construction of the east, or Illinois, approach to the new Municipal Bridge over the Mississippi River at St. Louis, Mo., was noted in our issue of May 13, 1915, and the organization under this system is shown by the accompanying drawing. Clinton H. Fisk is Chief Engineer.

The railway approach will be 2.3 mi. long, and the highway approach 0.7 mi. The structure will include 24,000 tons of steel and 35,000 cu.yd. of concrete. Boller, Hodge & Baird, of New York, are the consulting engineers; Brenneke & Fay, of St. Louis, act as the resident engineers.

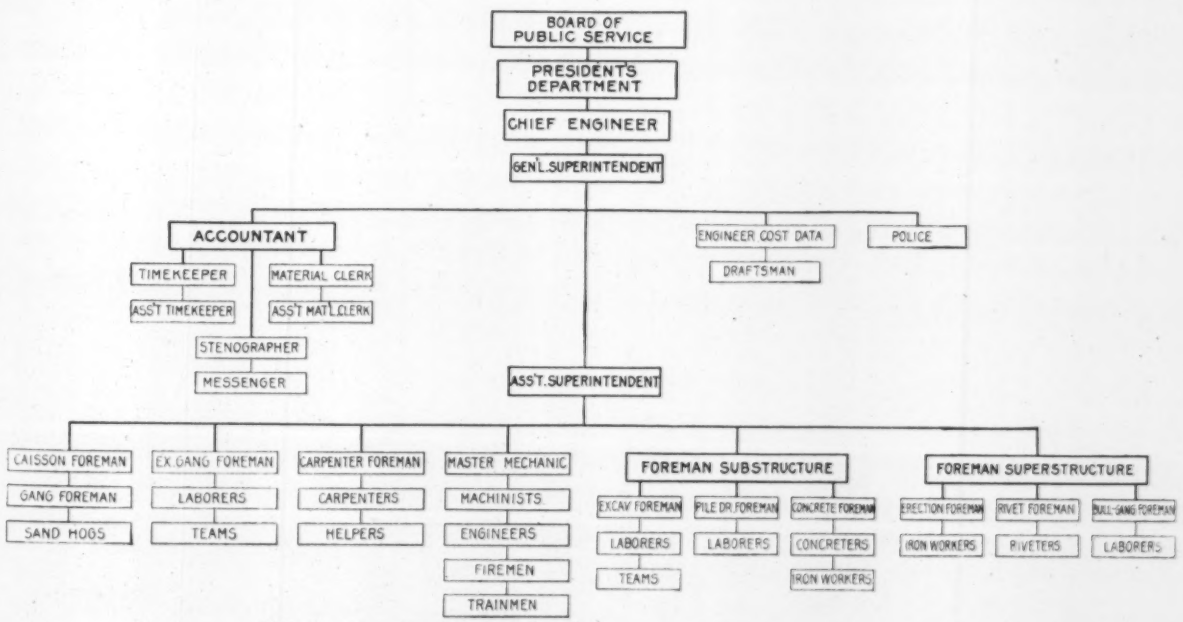


CHART OF ORGANIZATION FOR BUILDING EAST APPROACH OF ST. LOUIS MUNICIPAL BRIDGE

Rivets in Tension

Continuing the previous discussion in *Engineering News* concerning the admissibility of rivets for service in tension, V. H. Poss[1] describes how rivets showed their superiority over bolts in the San Francisco earthquake and fire of 1906. In those steel-frame buildings that collapsed in whole or in part, he observed that bolted field-connections had almost invariably given way by the bolts breaking off; in all-riveted work, on the other hand, the connection angles tore apart at the root, leaving each leg fast to the member to which it was riveted. This occurrence furnishes good testimony in favor of rivets in tension.

Using rivets in tension for wind-bracing connections is sound practice, Mr. Poss believes; but where load is carried directly, whether dead- or live-load, and failure would result in serious damage, neither rivets nor bolts in tension can be considered reliable.

As to the harmful effect of initial tension in rivets, he shows by an example that its influence is usually small. If the compressed area of plate under the rivet is four times the sectional area of the rivet shank [this seems a conservative assumption—Editor], then an initial stress of 12,000 lb. per sq.in. in the rivet gives a compression of 3,000 lb. per sq.in. in the plate. When tensile load comes on the rivet, it is resisted partly by further stretch of the rivet, but more by the relief of compression in the plate. The plate compression is entirely relieved by the time the rivet tension has increased to 15,000 lb. per sq.in., at which stage, therefore, the initial stress loses all its influence. Tension in rivets is actually utilized in nearly all riveted work, but especially in the cover-plate riveting of girder flanges, William Vetter[2] points out. The shear between plates is resisted by friction and not by rivet bending, and this plate friction is produced wholly by the tension in the rivet. If it is not good practice to depend on this tension, a new design for girder flanges is necessary, in which no rivet shall pass through more than two thicknesses of metal.

[1]Consulting Engineer, 57 Post St., San Francisco, Calif.

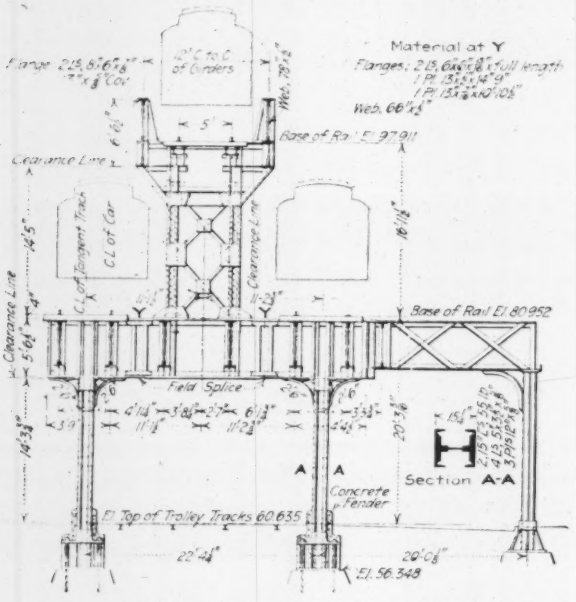
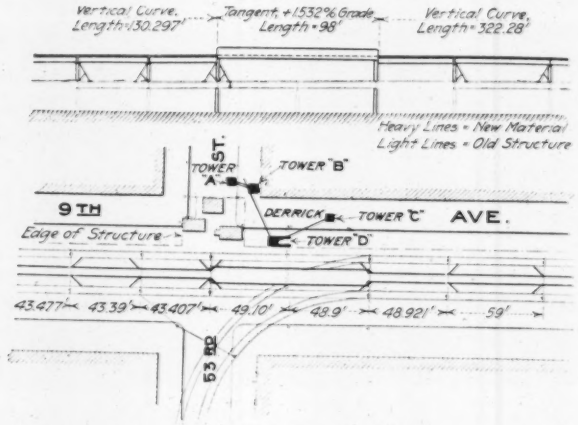

Material at Y
Flanges: 2 Pl. 6 1/2" x full length
1 Pl. 13 1/2" x 14" - 9"
1 Pl. 13 1/2" x 10' - 10 1/8"
Web, 66 1/2"
Base of Rail El. 97.911
Clearance Line
C.L. of Tangent Track
C.L. of Car
Base of Rail El. 80.952
Field Splice
Section A-A
Concrete Fender
El. Top of Trolley Tracks 60.635
El. 56.348

FIG. 1. "HUMP" TRACK AT 53RD ST. TURNOUT, NINTH AVE. ELEVATED, NEW YORK CITY

A Special Hoisting Job

Two plate-girders 100 ft. long had to be set for track elevation over the elevated-railway structure at 53d St. on the Ninth Ave. line, New York City, a short time ago. Inasmuch as the operation was bound to interrupt traffic, it had to be done in the shortest possible time. The contractors, Terry & Tench, Inc., laid out their plant with this end in view.



A 75-ton steel derrick was used to do the lifting. A signal-tower projection of the elevated structure limited the location in a rather awkward way, as the plan in Fig. 1 shows. To reach the final position of the girders the derrick had to be placed practically at the level of the elevated structure, about 20 ft. above street. This meant supporting the mast and stiff-legs on towers.

[2]Civil Engineer, 2463 Marion Rd., Fordham, New York City.

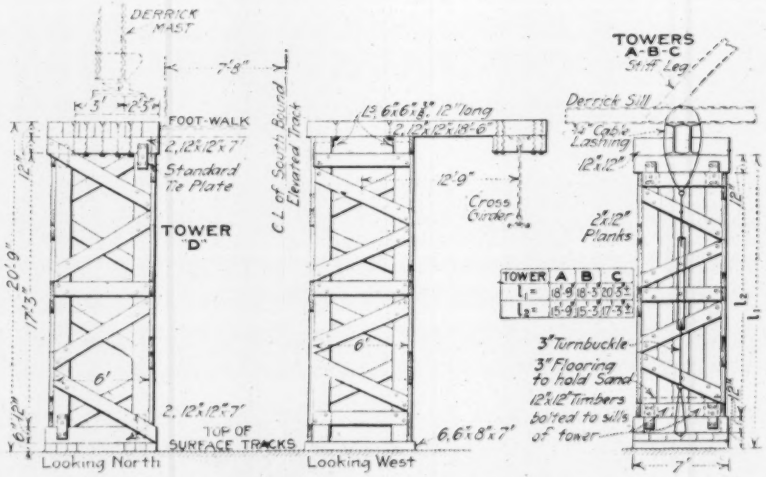


FIG. 2. DERRICK TOWERS

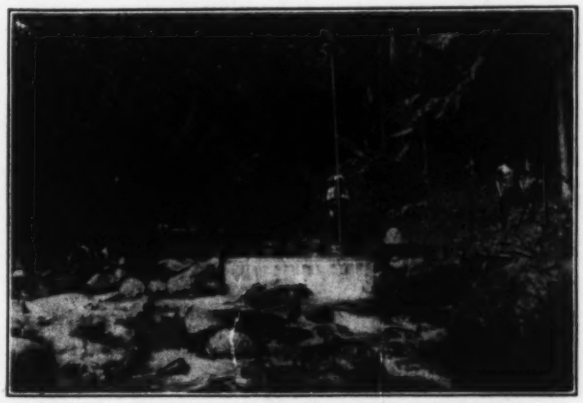
Fig. 2 shows in sketch form the construction of the towers. For taking the uplift on the stiff-legs these towers were filled with sand, the weight of which was taken by an anchor rope carried down from the two I-beams capping the tower to a platform in the bottom.

The long girders make a crossing of the raised middle express track over a turnout of the local track (to the Sixth Ave. line); they are located as shown in Fig. 1. Each girder weighs 27 tons. They were brought by team to the site and stored in the street just north of the derrick. In this position the derrick had to reach some 65 ft. in making the lift, but in a position where the uplift on the west stiff-leg was very slight. The girder was hoisted and the boom topped in, swinging out only enough to allow the girder to clear the mast. After getting above the level of the elevated structure, it was moved directly south by a combination of topping and swinging movements and set in place on the permanent supporting bents already erected. As soon as it was held by a few bolts, the operation of trains past the point of working could be resumed.

In setting the first of the two girders, train operation was stopped only 12 min. The second girder required 22 min. interruption.

The derrick had 36-ft. mast and 70-ft. boom, of structural steel with steel fittings. This derrick, if properly anchored, is capable of lifting its capacity at a reach of 40 ft. It has no bullwheel, but was swung by side lines from the end of the boom, going to the engine by way of lead-blocks. Tag-line tackle was also used.

While the hoist was not very heavy, the awkwardness of the location and the necessity of doing the job rapidly and with certainty made it an unusual and rather anxious piece of work. All persons concerned were gratified at the speed of working realized. Holton D. Robinson was engineer for the contractors and W. R. Coppage was superintendent. The work was done for the Interborough Rapid Transit Co., George H. Pegram, Chief Engineer.



WEIR AND SURVEYING PARTY IN BURMA

FIG. 3. HOISTING SECOND 100-FT. GIRDER AT 53RD ST.

Stream-Gaging in Burma

Engineering, wherever it may be, employs much the same methods. The accompanying view will present a familiar appearance to many civil engineers. Take away the banana trees and the bamboo, and it could well serve for similar operation of stream measurement in most any temperate country. Yet the original photograph was taken far in the interior of Burma, where few engineers have penetrated before.

The weir shown is the standard contracted weir, and the water quantities were computed by the Francis formula.

The lumber used in the weir was teakwood, freshly cut. Teakwood, when freshly cut, has a strong, not unpleasant, pungent odor which rather effectually drives away mosquitoes and gnats—a welcome relief to the European.

The young man by the level is not the engineer, but the engineer's muscles, his duty being to carry the instrument and set it up, leaving only the centering and final leveling up (and of course the reading of angles) to be done by the engineer.

The rodman, a dignified, turbaned Hindu, in his slow way was rather an efficient workman and performed his duties creditably.

It has been my observation that an unskilled laborer is the same as any other form of engine, and like any other heat engine can only perform as much work as the fuel it consumes. The Hindu is a notoriously light feeder, and most of his foods are low in calorific value; consequently he is not strong in energy.—J. D. Swaren, Hayward, Calif.